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NUCLEAR SCIENCE ABSTRACTS

CHEMISTRY

Analytical Chemistry

Refer also to abstracts 8267, 8543, 8794, and 9186.

8187 (AECL-2643) METHODS FOR ANALYSIS OF ORGANIC COOLANTS. A Summary of Current Canadian Practice. Stewart, R. B.; Smee, J. L. (Atomic Energy of Canada Ltd., Pinawa (Manitoba). Whiteshell Nuclear Research Establishment). May 1966. 18p. (CONF-660553-3). Dep. mn. AECL $0.50.

From Panel on Use of Organic Liquids as Reactor Coolants and Moderators, Vienna, Austria.

Methods used in current Canadian practice for the analysis of terphenyl reactor coolant mixtures are briefly described. They deal with major constituents, physical properties, impurities, radioactivities, and coolant-quality tests. While the procedures outlined are generally satisfactory, comments are made as to the desirable objectives in further analytical method development for these materials. These include emphasis on continuous in-line measurements of fouling, physical properties, gases, and radionuclides. (auth)

8188 (CEA-R-3095) DOSAGE DES PRODUITS DE FISSION DANS LES EFFLUENTS DE TRAITEMENT DES COMBUSTIBLES IRRADIES (ELECTROPHORESE). (Fission Product Determination in Irradiated Fuel Processing Waste (Electrophoresis)). Auchapt, Jacqueline-Marguerite; Tret, Joeel (Commissariat a l'Energie Atomique, Chusclan (France). Centre de Production de Plutonium de Marcoule). 1966. 23p. (In French). Dep. mn.

This determination method concerns fission products present in waste produced from the processing of cooled irradiated fuels. Sr, Cs, Ce, Y, and Ru were determined by quantitative analysis and Zr and Nb by qualitative analysis. It includes electrophoresis on paper strips one meter long, which are then analyzed between two windowless Geiger counters. For an activity of 10^{-2} μCi of any cation in a 10 μl spot, the standard error is 3 to 4%. A complete analysis lasts about 5 hrs. (auth)

8189 (IS-T-113) CHROMATOGRAPHIC SEPARATIONS OF NIOBIUM, TANTALUM, MOLYBDENUM, AND TUNGSTEN. Dahmer, Lionel Herbert (Ames Lab., Iowa). Nov. 1966. Contract W-7405-eng-42. 79p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Thesis.

Molybdenum, tungsten, niobium, and tantalum were quantitatively separated by cation exchange from many other metal ions. In the presence of excess peroxide in acidic solution, these four metal ions form anionic peroxy complexes which are not retained by cation exchange resin. Other metal ions which do not form such complexes are retained by the resin and are thus separated from the four title elements. Recoveries for molybdenum and other metal ions were about 99.8%. A partition chromatographic method for separation of niobium, tantalum, molybdenum, and tungsten from each other was developed by adapting the hydrochloric acid, hydrofluoric acid–methyl isobutyl ketone system to a column. Batch distribution ratios were determined for the metal ions from various combinations of hydrochloric, hydrofluoric, and sulfuric acid into methyl isobutyl ketone. Tantalum, niobium, and molybdenum were highly extracted from a 7 M hydrochloric to 2 M hydrofluoric acid solution, while tungsten had a low distribution ratio. By increasing the hydrofluoric acid concentration to about 8 M, and decreasing the hydrochloric acid concentration to about 4 M, the distribution ratio for molybdenum was lowered greatly. The separations and radiochemical determinations of trace quantities of the four metals were very successful. In three different separations, one part of radioactive niobium, tantalum, or tungsten was separated from 10^7 parts of the other three inactive metal ions. Quantitative recovery was also obtained in the separation of one part of radioactive molybdenum from 10^6 parts each of tantalum, niobium, and tungsten. (P.C.H.)

8190 (K-L-6119) SEPARATION AND ANALYSIS OF NATURAL WATER. Lammers, William T. (Davidson Coll., N. C. Oak Ridge Gaseous Diffusion Plant, Tenn.). Aug. 17, 1966. Contract W-7405-eng-26. 23p. (CONF-660907-2). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

From American Chemical Society Meeting, New York.

The separation and determination of suspended and colloidal sized organic particles typically found in natural water are discussed. However, the same theories and general methods apply to similar particles in other fluids and to inorganic particles. Also, an assessment was made of what was known of the chemical, biological, and physical characteristics of suspended, colloidal, and dissolved particles reported in natural water. The fractions isolated by the techniques outlined are characterized by suitable analytical techniques to determine both the size of the fraction (number of particles) and the identity of the particles in the fraction. (P.C.H.)

8191 (LA-3540) EQUILIBRIUM ANION EXCHANGE OF URANIUM(VI) ON DOWEX 1X4 FROM NITRIC ACID SOLUTIONS. James, D. B. (Los Alamos Scientific Lab., N. Mex.). June 21, 1966. Contract W-7405-eng-36. 16p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Equilibrium exchange isotherms for uranium(VI) sorbed on Dowex 1X4 anion exchange resin from nitric acid solutions were determined for 5, 7, and 8.3M nitric acid at 24°C and for 7M nitric acid at 40 and 60°C. The results were numerically fitted by a least-squares technique to mass-action theory, assuming sorption as $UO_2(NO_3)_3^-$ and $UO_2(NO_3)_4^{--}$. (auth)

8192 TITRATION OF URANIUM(IV) WITH CERIUM(IV) SULFATE BY USING SETOCYANINE OR XYLENE CYANOLE FF AS INDICATOR. Rao, K. Bhaskara (Hindustan Aircraft Ltd., Bangalore, India). Chem.-Analyst, 54: No. 3, 70-1(1965).

The titration of U(IV) with $Ce(SO_4)_2$ in 0.5M H_2SO_4 or $HClO_4$ was made without the addition of H_3PO_4 when 0.1% aqueous Setocyanine (C. I. Basic Blue 5) or Xylene cyanole FF (C. I. Acid Blue 147) was used as internal indicator. The end-point was sharp, the titration error was negligible, and either indicator could be used in 0.25M to 2.5M H_2SO_4 or 0.5M to 5M $HClO_4$. (Analytical Abstr.)

8193 CHARACTERISTIC X RAYS FROM (n,γ) PRODUCTS AND THEIR UTILIZATION IN ACTIVATION ANALYSIS. Pilay, K. K. Sivasankara. University Park, Pa., Pennsylvania State Univ., 1965. 117p.

Thesis.

The possibility of using characteristic x rays in activation analysis was investigated, with particular emphasis on (n,γ) products. The use of characteristic x rays in activation analysis has several advantages over γ spectrometry and other particle detection methods, because the energies of these radiations are related to the periodicity of the elements themselves, and as such they have an undisputable identity. Most of the elements above nickel in the periodic table were irradiated in a thermal neutron flux and the identification and measurability of the (n,γ) products using characteristic x rays were made using proportional counters and a 1/4-inch sodium iodide scintillation crystal. At least 27 of 56 elements investigated during this work were found to yield themselves to activation analysis employing characteristic x rays from

electron capture decay or internal conversion process during isomeric transition. The details of instrumentation, limitations in the detector systems and the sources of interferences were discussed. A survey made of several elements for the detection and measurement of their (n,γ) products using characteristic x rays is given. Each of the observed spectra is discussed and some of the salient features of these spectra were tabulated. The discussion mostly involved characteristic x rays, though in case of some high atomic number elements, the L x rays observed were pointed out. The limits of detection of 22 elements are reported. A few ores and minerals were analyzed for their metal content with very few or no chemical separations. The accuracy of quantitative determinations was confirmed by the analysis of four NBS steel samples for their copper contents. A high-iron-content silicate rock bearing copper sulfide was analyzed for its copper content. Specific applications of this method were studied for the analysis of copper in a variety of samples (minerals, ores, steels, spent lubricants and human blood). Two applications of this method made by other research groups were mentioned. Results show that characteristic x rays from (n,γ) products of a number of elements can be used in activation analysis. (Diss. Abstr.)

8194 ISOTOPIC EXCHANGE REACTIONS OF ATOMIC OXYGEN PRODUCED BY THE PHOTOLYSIS OF NO_2 AT 3660 A. Jaffe, Sigmund; Klein, Fritz S. (Weizmann Inst. of Science, Rehovoth, Israel). Trans. Faraday Soc., 62: 3135-41(Nov. 1966).

Isotopically labeled atomic oxygen, produced by the photolysis of $N^{18}O_2$ at 3660 Å, was allowed to react with CO, CO_2, N_2O, O_2 and $COCl_2$, respectively. The rates and mechanisms of the exchange reactions are discussed. The specific rate constants were determined for the process, $O^* + XO \rightarrow O^*X + O$. They are $6.2 \times 10^{10} \exp[(-6900 \pm 700)/RT]$, $6.3 \times 10^{8} \exp[(-3500 \pm 200)/RT]$, $9.6 \times 10^{8} \exp[(-4400 \pm 800)/RT]$, and $3.9 \times 10^{9} \exp[(-1100 \pm 400)/RT]$ l mole^{-1} sec^{-1} for CO, CO_2, N_2O, and O_2, respectively. (auth)

8195 ACTIVATION ANALYSIS OF SHORT-LIVED ISOTOPES: STUDY OF THE NONDESTRUCTIVE DETERMINATION OF HAFNIUM (^{179m}Hf, T = 19S) AND ITS APPLICATIONS. Haerdi, W.; Balsenc, L.; Monnier, D. (Univ., Geneva). Chimia (Aarau), 20: 429-30(Dec. 15, 1966). (In French).

A method is described for radiochemical assay of hafnium based on the formation of ^{179m}Hf (and ^{178m}Hf) after activation with thermal neutrons. The interferences due to aluminum, iron, and many other metals were studied. A method is described for the direct assay (without dissolution or separation) of Hf in zirconium salts, metallic zirconium, and Zircaloy. (auth)

8196 ACTIVATION ANALYSIS OF SHORT-LIVED ISOTOPES: REACTIONS PRODUCED BY FAST NEUTRONS FROM THE REACTOR AGN-201-P. Monnier, D.; Daniel, R.; Haerdi, W. (Univ., Geneva). Chimia (Aarau), 20: 428-9(Dec. 15, 1966). (In French).

Reactions, which occurred by irradiating with fast reactor neutrons and which allowed analyses not possible with thermal neutrons, are described. These reactions are either of type (n,a), (n,p), or (n,n'). Thus occurring radioisotopes have a very short half-life, generally less than a few minutes. Examples are given in each case. Dosing tungsten in steels was studied with the very short half-life isotope ^{183m}W (T = 5.5 seconds). A special mention is given to the reaction: $^{89}Y(n,a)^{86m}Rb$. (auth)

8197 STEEL ANALYSIS WITH ARSENAZO III. IV. SPECTROPHOTOMETRIC DETERMINATION OF THORIUM IN NITRIC ACID SOLUTION. Kammori, Ohiko; Taguchi, Isamu; Yoshikawa, Kenzi (Yawata Iron and Steel Works, Kawasaki, Japan). Bunseki Kagaku, 14: 548-50(1965). (In Japanese).

The method of Kawahata et al. was improved by use of HNO_3 instead of HCl. The molecular extinction coefficient of the Th complex (8.3×10^4) was smaller than in HCl, but the stability was greater. The extinction was affected by Fe (up to 30 mg), and the calibration graph should be prepared in the presence of a given amount of Fe (e.g., 20 mg). The error was $< \pm 0.005\%$ for 0.01 to 0.5% of Th, and there was no interference from common constituents of iron and steel, except Zr. The sample (0.2 g) was heated with HNO_3 (1:1) (10 ml), the solution diluted to 100 ml and to a 10-ml aliquot HNO_3 (40 ml), urea solution (10%) (5 ml), and, after a few minutes arsenazo solution (0.1%) (5 ml) were added. The extinction was measured at 662 mμ against water. (Analytical Abstr.)

8198 ARSENATE METHOD OF IODOMETRIC DETERMINATION OF YTTRIUM IN THE PRESENCE OF SCANDIUM. Shakhtakhtinskii, G. B.; Valiev, B. S.; Aslanov, G. A. Dokl. Akad. Nauk Azerb. SSR, 22: No. 1, 12-15(1966). (In Russian).

A method was developed for determining yttrium iodometrically as the arsenate in the presence of scandium (at least 0.3 mg of Y in the presence of up to 20 mg of Sc per 25 ml of solution). In order to precipitate the yttrium ion with arsenate ions, heating of the solution should be discontinued immediately after the appearance of turbidity, since further heating leads to the formation of an amorphous precipitate which contains scandium. If such a precipitate does form, 5 to 6 drops of 1N HCl should be added; this dissolves the amorphous scandium precipitate, but the crystalline yttrium arsenate is not affected and deposits quantitatively. Yttrium as the arsenate was determined iodometrically. About 40 to 50 min were required for the analysis. (ATD)

8199 NEUTRON-ACTIVATION ASSAY FOR LANTHANUM AND SAMARIUM IN MINERALS. Babaev, A.; Lobanov, E. M. Dokl. Akad. Nauk Tadzh. SSR, 6: No. 6, 12-17(1963). (In Russian).

Samples of monazite, orthite, davidite, and euxenite, together with La and Sm standards, were irradiated in a neutron flux of $\simeq 1.2 \times 10^{12}$ thermal neutrons per cm^2 per sec for 10 min. The induced radioactivity due to ^{140}La and ^{153}Sm was measured with a scintillation spectrometer, with a NaI(Tl) detector crystal. (Analytical Abstr.)

8200 DETERMINATION OF COPPER, MANGANESE, AND COBALT IN URANIUM SOLUTION BY NEUTRON ACTIVATION. Marchart, H.; Hecht, F. (Univ., Vienna). Monatsh. Chem., 95: 742-9(1964). (In German).

Uranium was separated from the other elements by extraction with tributyl phosphate solution in CCl_4 from 6N HNO_3 medium, and the residue after evaporation was irradiated in a neutron flux of $\simeq 6 \times 10^{12}$ neutrons per cm^2 per sec. The irradiated sample was allowed to decay for 15 hr and examined on a multi-channel analyzer. About 5 μg of Ca, Mn, or Co per ml can be determined with a precision of ±0.2 μg in solution containing 50 mg of U per ml. (Analytical Abstr.)

8201 POLAROGRAPHIC ANALYSIS OF RARE-EARTH ELEMENTS. Perov, E. I.; Serebrennikov, V. V. Tr. Tomsk. Gos. Univ., Ser. Khim., 157: 123-7(1963). (In Russian).

A procedure is described for the polarographic determination of Eu and Yb in the presence of other rare earth elements (r.e.e.). In a basal solution of 0.1M KCl, Eu and Yb give waves of $E_{\frac{1}{2}} = -0.71$ and -1.395 V (vs the S.C.E.), respectively, the heights being proportional to the concentration of the elements within the range 5×10^{-5} to 2×10^{-3}M. The wave due to Yb is most distinct at pH 5 to 6. The error of the determination is ±5% for Eu and ±10% for Yb. Large amounts of Sm and Ce interfere. (TSS)

8202 PRODUCTION OF PREPARATIONS OF CARBON FROM NATURAL GASES FOR ISOTOPE ANALYSIS. Nesmelova, Z. N.; Dubrova, N. V. Tr. Vses. Nauch.-Issled. Geologorazved. Inst., No. 227, 250-4(1964). (In Russian).

The gas, fractionated by chromatography if necessary, was ignited over CuO at 850 to 900° in evacuated apparatus to produce CO_2; the H_2O produced was absorbed by P_2O_5. The initial volume of gas was 15 to 30 ml, and the ignition took 15 to 20 min. The completeness of conversion into CO_2 was controlled chromatographically. The CO_2 produced was freed from N, inert gases and possible traces of O and other gases by freezing out in a liquid-oxygen trap. The pure CO_2 was transferred to a glass ampoule, which was sealed under vacuum, and subjected to mass-spectrographic analysis. (Analytical Abstr.)

8203 INVESTIGATIONS OF SOME MOTOR-OIL ADDITIVES BY NEUTRON ACTIVATION. Nagy, L. G.; Szokolyi, L. (Polytechnical Univ., Budapest). Periodica Polytech., 8: No. 1, 41-62 (1964).

A comparison was made of the neutron activation determinations of elements commonly present in motor-oil additives, Ba, P, S, and Zn. These elements can be detected easily by comparing the irradiated oil and suitable standards by γ spectroscopy, or by measuring β or γ absorption or the half-lives of the radioisotopes produced. Results are tabulated. (Analytical Abstr.)

8204 SEPARATION OF ALKALINE-EARTH ELEMENTS ON ION EXCHANGERS. Hantabal, E.; Fojtik, M.; Rusek, V.; Trnovec, T. (Inst. Hygiene and Industrial Diseases, Bratislava). Chem. Zvesti, 18: 203-8(1964). (In Czech).

Calcium, barium, strontium, and radium in urine or water were separated using an ion exchanger (Catex S) with strontium-90 and barium-140 as carriers. Details of the procedure are given. (TSS)

8205 DETERMINATION OF POTASSIUM IN SOLIDS AND LIQUIDS BY MEASUREMENT OF THE GAMMA ACTIVITY OF NATURALLY RADIOACTIVE ^{40}K. Harris, W. G.; Kessler, W. V.; Christian, J. E.; Schall, E. D. (Purdue Univ., Lafayette, Ind.). J. Agr. Food Chem., 12: 144-6(1964).

Solid (K salts) and liquid (fertilizer) samples (≃1500 g) were counted without sample preparation by means of a 4-π, 8-in. × 4.5-in. liquid-scintillation counter, operated with the base discriminator set so that all energies >0.075 MeV were detected. Determinations were based on 2-min counts, preceded and fol-

lowed by 1-min background counts. The coefficient of variation for repeated measurements on the same sample was <2% for samples containing >5% K. The method is suitable for routine analysis, provided that the sample has no radioactive contamination, and a determination takes ≈10 min. Samples containing <5% of K could be analyzed by extending the counting time. (Analytical Abstr.)

8206 SIMPLE APPARATUS FOR COMBUSTION OF SAMPLES CONTAINING PESTICIDES LABELLED WITH ^{14}C FOR RESIDUE ANALYSIS. Smith, G. N.; Ludwig, P. D.; Wright, K. C.; Bauriedel, W. R. (Dow Chemical Co., Midland, Mich.). J. Agr. Food Chem., 12: 172-5(1964).

The simple apparatus described and illustrated consists of four main parts—a carbon dioxide scrubber, a combustion unit, an iodine trap, and a carbon dioxide absorber. The apparatus, which can be used to trap the CO_2 as $BaCO_3$ or in ethanolamine solution for scintillation counting, is rapid, simple, and safe to operate, and can be used with any type of biological sample, e.g., albumin, fat, tissue, blood, roots, stems, and leaves. (Analytical Abstr.)

8207 DETERMINATION OF THE RARE-EARTH ELEMENTS OF THE CERIUM GROUP BY RADIOMETRIC TITRATION WITH 8-HYDROXYQUINOLINE. Maryanov, B. M.; Serebrennikov, V. V. Tr. Tomsk. Gos. Univ., Ser. Khim., 157: 8-11 (1963). (In Russian).

It was found that Ce^{3+} and Nd^{3+} can be titrated radiometrically with 8-hydroxyquinoline in solution of pure salts, with ^{147}Pm as radioactive indicator. The titration is carried out in ammoniacal buffer solution at pH 9 in the presence of tartrate to prevent the precipitation of hydroxides. In the titration of Ce, hydroxylammonium chloride is added to the solution to prevent oxidation of Ce^{3+} to Ce^{4+}. Titration with 8-hydroxyquinoline was used to determine considerably smaller amounts of the rare earth elements than does radiometric titration with oxalic acid and the long delay to ensure complete precipitation was avoided. The error of determination is ±5%. Results for the titration of elements of the Y group were unsatisfactory, apparently because of the precipitation of double tartrates. (Analytical Abstr.)

8208 ANALYSIS BASED ON ISOTOPIC DILUTION OF RADIOACTIVE MATTER. Klas, J. (Inst. of Chemical Tech., Bratislava). Chem. Zvesti, 18: 250-8(1964). (In Czech).

The accuracy and optimum conditions of analysis by direct and reverse isotopic dilution were studied by the use of an equation expressing the relative deviation of the analysis. (Analytical Abstr.)

8209 MASS SPECTROMETRIC TRACE ANALYSIS OF CALCIUM, STRONTIUM, AND BARIUM IN SODIUM AZIDES BY ISOTOPE DILUTION TECHNIQUES. Riepe, W.; Kaiser, H. (Institut fuer Spektrochemie und Angewandte Spektroskopie, Dortmund, Ger.). Z. Anal. Chem., 223: 321-35(1966). (In German).

Isotope dilution technique combined with isotope analysis by mass spectrometry is considered a preferable method for determination of 0.1 μg of Sr and Ba, and 1 μg of Ca, respectively, in sodium salts. For the concentration range from 1 to 1000 ppM the relative standard deviations are for Ca 1.2%, Sr 0.6%, and Ba 0.7%. A discussion of the propagation of errors allows the selection of optimum conditions for this analytical procedure of isotope dilution. Limits of detection are calculated. (auth)

8210 POSSIBILITY OF ELEMENTAL ANALYSIS BY USE OF NEUTRON-CAPTURE γ-RAYS DUE TO NEUTRONS FROM LOW-LEVEL SOURCES. Okada, Minoru. Tokyo Kogyo Shikensho Hokoku, 61: 448-55(Oct. 1966). (In Japanese).

An outline of an improved device using 50- and 250-mCi radium–beryllium neutron source together with water and paraffin, respectively, is presented for possible detection of capture γ rays of Gd, Sm, Cd, Dy, Cl, Co, Ag, Sc, Mn, Se, N, Ti, Ni, and Cr. As far as a low-level neutron source is used a high sensitivity and a rapid method will not be realized in the elemental analysis of this kind. (auth)

8211 DETERMINATION OF ^{18}O CONTENT BY MEANS OF DETECTION OF γ QUANTUM EMITTED FROM $^{18}O(\alpha,n\gamma)^{21}Ne$ REACTION. Lemberg, I. Kh.; Girshin, A. B.; Gusinskii, G. M. (Ioffe Inst. of Physics and Tech., Leningrad). Zavodsk. Lab., 32: 1499-1501(1966). (In Russian).

A method is suggested for determining the content of stable ^{18}O isotope by the $^{18}O(\alpha,n\gamma)^{21}Ne$ reaction using α particles accelerated by a cyclotron to 4.6 MeV. The content of ^{18}O was determined by the yield of γ quanta emitted by the excited ^{21}Ne. Obsolete sensitivity of the method for ^{18}O was 2×10^{-9} g, and for the natural oxygen 10^{-6} g. (tr-auth)

8212 PREPARATION OF SECONDARY STANDARDS FROM MINERALS OF LOW URANIUM CONTENT. Lopez Morales, J.; Gasco Sanchez, L.; Petrement Eguiluz, J. (Junta de Energia Nuclear, Madrid). An. Real Soc. Espan. Fis. Quim. (Madrid), Ser. B, 62: 1255-66(Nov. 1966). (In Spanish).

With the aim of having available standards to check the accuracy of new methods for uranium determination, several samples of secondary minerals with low uranium contents have been prepared. Their homogeneity was proved by the spectrophotometric methods using dibenzoylmethane, arsenazo, and sulfocyanide ions as reagents. The accuracy of the analytical methods applied to minerals of various composition has been studied by means of a statistic approach to the results. The levels of U_3O_8 in each sample are given. (auth)

8213 CHROMATOGRAPHIC TECHNIQUES USING LIQUID ANION EXCHANGERS. III. SYSTEMATIC THIN-LAYER CHROMATOGRAPHY OF THE ELEMENTS IN HCl SYSTEMS. Brinkman, U. A. Th.; De Vries, G.; Van Dalen, E. (Free Univ., Amsterdam). J. Chromatog., 25: 447-63(Dec. 1966).

Using thin-layer chromatography on silica gel impregnated with Alamine 336, Amberlite LA-1 or Primene JM-T, the behavior of approximately 55 ions in an HCl system has been systematically investigated. Data have also been collected on the behavior of most ions on the non-impregnated support. When comparing the R_F spectra obtained with literature data concerning related methods, a satisfactory overall agreement is found. Moreover, for some elements tentative conclusions about the exchange mechanism were reached. The thin-layer technique previously described has been standardized and suitable apparatus developed. A number of successful separations are reported and in a few cases the advantages of these methods over those described in the literature are indicated. (auth)

8214 ANALYSIS OF CONTAMINANTS IN URANIUM COMPOUNDS BY POST-IRRADIATION PAPER CHROMATOGRAPHY. Oerdoegh, M.; Upor-Juvancz, V. (Central Research Inst. for Physics, Budapest). J. Chromatog., 25: 464-70(Dec. 1966).

A method for the determination of several impurities in reactor grade uranium compounds by post-irradiation paper chromatography is described. The bulk of the uranium is removed before irradiation by spotting the uranyl nitrate solution on to a Schleicher and Schüll 2043A paper, then chromatographing with diethyl ether containing 5 vol % nitric acid as solvent. The paper strip containing the contaminants which did not move away from the starting point is ashed, then irradiated. After irradiation it is dissolved and the hydrochloric acid solution chromatographed using ethyl alcohol-hydrochloric acid-water (75:20:5) as solvent. The chromatogram is then cut into sections and measured by gamma spectrometry. (auth)

8215 SPECTROGRAPHIC ANALYSIS OF URANIUM–MOLYBDENUM ALLOYS. Roca, Miguel (Junta de Energia Nuclear, Madrid). An. Real Soc. Espan. Fis. Quim. (Madrid), Ser. B, 62: 1165-70(Nov. 1966). (In Spanish).

A spectrographic method of analysis has been developed for uranium–molybdenum alloys containing up to 10% Mo. The carrier distillation technique, with gallium oxide and graphite as carriers, is used for the semiquantitative determination of Al, Cr, Fe, Ni, and Si, involving the conversion of the samples into oxides. As a consequence of the study of the influence of molybdenum on the line intensities, it is useful to prepare only one set of standards with 0.6% MoO_3. Total burning excitation is used for calcium, employing two sets of standards with 0.6 and 7.5% MoO_3. A carefully controlled conversion of the samples into oxides, at 550°C, is necessary for the quantitative determination of molybdenum, to avoid losses of Mo and to get the total conversion of the uranium into U_3O_8. The samples are diluted with graphite (1:9), using cobalt as internal standard, and dc arc total burning excitation. The standard deviation is ±8% and the results are in good agreement with those obtained by chemical methods. (auth)

8216 POLAROGRAPHIC DETERMINATION OF Cu, Cd, Ni, Co, Pb, AND Zn IN URANIUM AND ITS COMPOUNDS. Almagro, V. (Junta de Energia Nuclear, Madrid). An. Real Soc. Espan. Fis. Quim. (Madrid), Ser. B, 62: 1129-38(Nov. 1966). (In Spanish).

The method proposed is based upon previous separation of uranium by organic solvent extraction of the uranium–tributyl phosphate complex using ammonium nitrate as saline displacing agent. In order of convenience, the organic solvents used for dilution were cyclohexane, carbon tetrachloride, and ethyl acetate. The aqueous phase containing the elements to be studied was taken to dryness in the presence of sulfuric and perchloric acids. Cu, Cd, Ni, Co, and Zn were determined polarographically in a background solution of either 2M pyridine–0.06 M pyridinium chloride or 1 M ammonium chloride–ammonium hydroxide. Pb and Zn were similarly determined in 5 M sodium hydroxide. The method is suitable for the determination of these elements

in uranium metal or in solutions of a high uranium content. The practical limits of applicability are 1 ppM with a 20% error for Cu and Cd and 10 ppM with errors ranging from 10 to 15% for Ni, Co, Zn, and Pb. 0.1 ppM of Cd and 0.5 ppM of Cu can be determined with an error of 60%. Possible interferences were investigated. Fe, Mn, Al, Sn, Ag and Cr do not interfere with the determination when present in amounts of 100 ppM or less. (auth)

8217 QUANTITATIVE ACTIVATION ANALYSIS FOR TRACES OF GOLD IN URANIUM MINERALS. Galiano Sedano, J. A.; Travesi Jimenez, A. (Junta de Energia Nuclear, Madrid). An. Real Soc. Espan. Fis. Quim. (Madrid), Ser. B, 62: 1119-28 (Nov. 1966). (In Spanish).

Neutron activation analysis was used to determine traces of gold in uranium ores. The method is based on the addition of isotopic gold carrier to the irradiated ore samples, followed by dissolution, radiochemical separation, and 5×10^{11} nV which permits the determination of as little as 2×10^{-8} grams of gold. The radiochemical purity of the gold precipitate is checked by gamma spectrometry with a scintillation crystal of NaI(Tl) and a multichannel analyzer. (P.C.H.)

8218 GAS CHROMATOGRAPHIC CHARACTERISTICS OF POLYTRIFLUOROMONOCHLOROETHYLENE COLUMNS AS APPLIED TO ANALYSIS OF URANIUM HEXAFLUORIDE AND OTHER VOLATILE INORGANIC FLUORIDES. Shinohara, Haruka (Japan Atomic Energy Research Inst., Tokyo); Asakura, Nobuhiko; Tsujimura, Shigeo. J. Nucl. Sci. Technol. (Tokyo), 3: 373-8(Sept. 1966).

A gas chromatographic assembly for analyzing UF_6 and other volatile inorganic fluorides was constructed. Column packings consisted of polytrifluoromonochloroethylene oil as partition liquid, and moulding powder as supporting solid, both substances being inert to UF_6 if the operation temperature is not too high. Through examination of the curves for peak height ratio between elution and inlet, it was found that, to obtain reproducible results, it was necessary to pretreat the columns with fluorine, use purified carrier gas, and establish a definite time schedule for sample introduction. Dependent of HETP on flow rate of carrier gas, operation temperature, degree of polymerization of polytrifluoromonochloroethylene oils, and liquid phase loading were studied, and conditions for obtaining small HETP are discussed. Gas chromatography of TeF_6 and MoF_6 were studied, and the possibility of separating these gases from UF_6 was demonstrated. (auth)

8219 NON-DESTRUCTIVE DETERMINATION OF HYDROGEN IN ORGANIC SOLVENTS BY NEUTRON SLOW-DOWN PROCESS. Ishii, Daido; Hirose, Yoji; Mori, Hideo; Kato, Koichi (Nagoya Univ., Japan). Bunseki Kagaku, 15: 1320-7(Dec. 1966). (In Japanese).

A rapid nondestructive method based on the slowing-down process of neutrons by hydrogen nucleus was investigated for determination of hydrogen content in organic solvent. Fast neutrons from an Am–Be neutron source were moderated by the sample to thermal neutrons, which were then measured by a BF_3-counter. The logarithm of the counting rate was found to be directly proportional to the content of hydrogen in the range 60 to 120 mg/ml using 50 ml sample. The immersion-arrangement was suitable for this determination and some graphite-blocks were used effectively as the thermal neutron reflector. The influence of coexisting carbon and oxygen content on the calibration curve was not perceptible. The application of the method into the range of lower hydrogen content, such as 0 to 100 mg/ml, was also examined. (auth)

8220 POSSIBILITY OF ANALYSIS OF SOME METALS FOR OXYGEN BY COUNTING DELAYED NEUTRONS PRODUCED BY $^{18}O(\gamma,p)^{17}N$ REACTION. Dorosh, M. M.; Mazyukevitch, N. P.; Shkoda-Ulyanov, V. A. At. Energ. (USSR), 21: 163-6(Sept. 1966). (In Russian).

The possibility of using $^{18}O(\gamma,p)^{17}N$ reactions for determining oxygen concentrations in metal bars by recording delayed neutrons is discussed. The yield of oxygen mixture from thick Be, Te, and Zr bars was calculated. The construction of strong-current mean energy accelerators would make a conveyor analysis of metals and alloys possible. (tr-auth)

8221 DETERMINATION OF CESIUM TRACES IN MINERAL SALTS BY MEANS OF NEUTRON ACTIVATION–ION EXCHANGE CHROMATOGRAPHY METHOD. Sterlinski, Slawomir; Dybczynski, Rajmund (Inst. of Nuclear Research, Warsaw). Nukleonika, 11: 533-53(1966).

A neutron activation–chromatographic method for the determination of traces of cesium that makes use of the short-lived isomer ^{136m}Cs is presented. Cesium was isolated from macro amounts (0.5 g sample) of lighter alkali metals on the column with MK-3 cation exchanger (phenolsulfonic resin) before irradiation. After irradiation this cesium fraction was further purified from interfering activities by multistep ion exchange chromatography on microcolumns involving both cation and anion exchangers. The activity of the 31-keV photopeak was measured by gamma–spectrometric techniques using a very thin NaI(Tl) crystal. The precision of the method (defined in terms of three standard deviations) was better than 12%. The sensitivity amounted to 4×10^{-11} g Cs, i.e., 8×10^{-9}%. The method was shown to be fully applicable to the analysis of various mineral salts. (auth)

8222 ANALYSIS OF PLUTONIUM URANIUM CARBIDE–IRON CERMETS BY ELECTROCHEMICAL METHODS. Milner, G. W. C.; Wood, A. J.; Phillips, G.; Weldrick, G. J. (Atomic Energy Research Establishment, Harwell, Eng.). Z. Anal. Chem., 224: 346-56(1967).

Electrochemical methods were developed for the direct determination of the main metallic constituents of 15 wt. % (Pu,U) C–10 wt. % Fe cermets. Samples were dissolved in nitric acid, followed by wet oxidation with a mixture of sulfuric and nitric acids to destroy organic matter. Plutonium was determined by a potentiometric titration procedure based upon the reduction of Pu^{VI} to Pu^{IV} with ferrous iron added in slight excess, followed by the titration of this excess with ceric sulfate. Precision of this determination on 4 mg amounts of plutonium is 0.1%. Both uranium and iron were determined by controlled-potential coulometry, but the method for iron included a contribution from plutonium and allowance was made for this. The precision of the uranium determination on 10 mg amounts is 0.25%, and the value for iron on 1 mg amount is also 0.25%. Results for the complete analysis of typical cermet samples are given. (auth)

8223 POLAROGRAPHIC BEHAVIOR OF THORIUM SALTS IN DIMETHYL FORMAMIDE AND DIMETHYL SULFOXIDE. Gritzner, G.; Gutmann, V.; Michlmayr, M. (Technische Hochschule, Vienna). Z. Anal. Chem., 224: 245-51(1967). (In German).

Anhydrous and hydrated thorium compounds give, in both dimethylformamide and dimethylsulfoxide, polarographic waves, which can be used for analytical determinations of Th(IV). Details are given for the half-wave potentials (vs. aqueous saturated calomel electrode), the nature of the limiting currents, and the influence of water. (auth)

8224 PHOTOMETRIC DETERMINATION OF PLUTONIUM (IV) IN THE PRESENCE OF PLUTONIUM(VI) WITH XYLENOL ORANGE. Milyukova, M. S.; Nemodruk, A. A. Radiokhimiya, 8: 246-8(1966). (In Russian).

Conditions for the photometric determination of Pu(IV) in the presence of large quantities of Pu(VI), using xylenol orange were established. The absence of interference of Pu(VI) in the determination of Pu(IV) with this indicator suggested a simple method for determining Pu(IV), into a 3-ml graduated test tube was introduced 0.1 to 1M HNO_3 so that the final HNO_3 concentration was 0.1M, then distilled water, 0.14 ml of a 0.001M xylenol orange solution, and the aliquot of the analyzed solution (containing 1.0 to 12 μg Pu(IV)) were added. The final volume of the solution was 3.00 ml. The solution obtained was used to fill a 10-mm cell, and the optical density was measured in a spectrophotometer at 560 mμ relative to a solution of the reagent of the same concentration in 0.1M HNO_3. The Pu(IV) content of the aliquot of the analyzed solution was found from a calibration curve plotted by using a standard tetravalent plutonium nitrate solution. The Pu(VI) content was found by determining the total Pu content and subtracting the Pu(IV) content. The technique permits the determination of Pu(IV) in solutions containing 0.25 μg Pu/ml and above in the presence of up to 275 times as much Pu(VI). (ATD)

8225 THE NONDESTRUCTIVE ACTIVATION ANALYSIS DETERMINATION OF THE CHIEF CONSTITUENTS OF LARGER SAMPLE PIECES (EXAMPLE USED: COINS). Wyttenbach, A. Helv. Chim. Acta, 49: 2555-63(1966). (In German).

A method of activation analysis for nondestructive determination of Ag, Cu, and Au in coins is described. Important characteristics of the method are the use of a rotating irradiation device, use of standards, which correspond as closely as possible to the shape and composition of the samples, and correction of the measured specific activities for variations in the Ag content and the thicknesses of the measured coins. The method was applied to 370 silver coins from the 15th and 16th centuries; the relative error amounted to ±1.7%. (tr-auth)

8226 SIMPLE METHOD FOR DETERMINATION OF $^{14}CO_2$ FROM EXPIRED AIR. Yeh, S. Y.; Cavanaugh, John H.; Woods, L. A. (Univ. of Iowa, Iowa City). J. Pharm. Sci., 55: 1212-15(Nov. 1966).

Since present procedures for measuring expired $^{14}CO_2$ require complicated apparatus, extreme care, and much time, 2 simple procedures for preparation of homogenous $^{14}CO_2$-containing samples for liquid scintillation counting were developed. The proce-

dures require simple apparatus and are practical for the routine simultaneous handling of many samples. In one procedure (A), the CO_2-absorbing agent and the carbonate solution are placed in one tube. Carbon dioxide is released from the carbonate solution by sulfuric acid and absorbed by phenethylamine directly. Added $NaH^{14}CO_3$ (16-8000 cpm/ml) is recovered nearly quantitatively in the amine phase. Similar results are obtained with another procedure (B), in which $^{14}CO_2$ is released from the carbonate solution and flushed with nitrogen into a counting vial containing absolute methanol and phenethylamine. The percentage recovery of $^{14}CO_2$ from sodium hydroxide–carbonate solution by procedure A is 104 ± 2.2 (S.D.). The percentage recovery of $^{14}CO_2$ from sodium hydroxide–carbonate solution by procedure B is 105 ± 3.5 (S.D.). (BBB)

8227 PERCENT PROBABLE ERROR IN RADIOACTIVE MEASUREMENTS USING ANALOG AND DIGITAL RATE-METERS. Lin, S. (Univ., Turin). Acta Isotop., 5: 353-68(1965). (In Italian).

A comparative analysis concerning the performance of the analog and the so-called digital rate meters is presented. After a short description of the operation principles of these devices, the percent probable error (% PE) in both cases is discussed. It is pointed out that the premise for a correct application of the formula, which is usually adopted to calculate the % PE when measuring by means of rate meters, is that $t \gg RC$ (time integration constant). In the opposite case, it is necessary to introduce a new function T (t) which is valid to calculate the % PE for any t. A comparison was made between % PE values of a rate meter and of a scaler as a function of RC in those cases when $t \gg RC$, and in the general case. On the basis of the results obtained, the usefulness of digital rate meters for general diagnostic examinations with radioisotopes, in which the variations of radioactivity in time take place relatively slowly was considered. (auth)

8228 EVOLUTION OF THE ISOTOPIC COMPOSITION OF URANIUM AND THORIUM IN SOIL PROFILES. Rosholt, J. N.; Doe, R. B.; Tatsumoto, M. (Geological Survey, Denver). Geol. Soc. Amer. Bull., 77: 987-1004(Sept. 1966).

Mass-spectrometric and α spectrometric analyses for ^{238}U, ^{235}U, ^{234}U, ^{232}Th, and ^{230}Th were made on several soils and soil profiles in glacial-derived parent material, volcanic rock, and shale. Three deep profiles from Minnesota represented typical well-developed soils on till and loess of Wisconsin age continuously sampled to depths of 6, 7, and 10 ft, respectively. Results on individual soil horizons, in these 3 profiles, showed similar trends in the variation of $^{234}U/^{238}U$ and $^{230}Th/^{238}U$ ratios, the predominant features being excess ^{230}Th and deficient ^{234}U compared to ^{238}U. The other soils and soil profiles had different variations which can be correlated by use of a model to describe U migration. The data collected provided information for interpreting the causes of U migration in soils and for constructing a tentative model to explain the isotopic evolution of U and Th in soil profiles. The proposed model indicates that U was leached at depth in the profile, preferential leaching of ^{234}U was continuous in the soil, and upward capillary migration of a fraction of the U with above-normal $^{234}U/^{238}U$ ratio tended to make U of high ^{234}U ratio available for isotopic exchange in upper soil horizons and for assimilation in organic complexes in surface soils which are rich in organic matter. Thus some of the organic-rich surface soils, which have had considerable time to develop, contain U with excess ^{234}U compared to ^{238}U. Interpretations from this model suggest that remixing of radioisotopes by geochemical processes contributes significantly, along with the usual physical processes of radioactive growth and decay, toward producing an isotopic composition near radioactive equilibrium. (BBB)

8229 SIMPLE DEVICE FOR THE MEASUREMENT OF RADIOACTIVE STERILE SOLUTIONS. Lin, S. (Ospedali Riuniti, Trieste, Italy). Acta Isotop., 5: 347-52(1965). (In Italian).

A simple device consisting of a Bang microburette connected with a modified Olovson-Gordh needle and a screened container is described. It was designed for dispensing precise quantities measured up to $^1/_{100}$ ml of sterilized radioactive solutions. (auth)

8230 NEUTRON ACTIVATION ANALYSIS OF URANIUM IN STONE METEORITES. Nix, Joe Franklin Fayetteville, Ark., Univ. of Arkansas, 1966. 79p.

Thesis.

The uranium content of the light and dark portions of the Fayetteville meteorite and the Pasamonte meteorite was determined using a neutron activation technique. The primary purpose of this work was to determine the ^{244}Pu age or the time interval between the cessation of nucleosynthesis in stars and formation of the meteorites. The meteorite samples were irradiated in a thermal neutron flux of 5×10^{12} n per cm^2 per sec. ^{239}Np was isolated from irradiated samples, exhaustively purified and beta counted. The purity of the neptunium fraction was checked by gamma spectroscopy. The uranium content of each meteorite was calculated by comparing the ^{239}Np activity resulting from the irradiated meteorite with that resulting from a flux monitor containing a known quantity of uranium. ^{237}Np was used as a tracer for the determination of chemical yield, which was usually around 10%. The major steps of the decontamination procedure consisted of the coprecipitation of neptunium with LaF_3 followed by an anion exchange purification. The neptunium fraction was absorbed onto a Dowex 1 × 4 resin from a nitric acid media after being reduced to Np(IV). Fission products and other contaminants were removed from the column by washing with a portion of nitric acid containing HF. The neptunium was eluted from the column and ultimately electrodeposited onto a stainless steel disc. The results, expressed in ppB, were as follows: Fayetteville meteorite, light portion, 29, 33, 32; average value = 31; Fayetteville meteorite, dark portion 23, 22, 18; average value = 21; Pasamonte meteorite, 134, 138, 125; average value = 132. The ^{244}Pu age of the meteorite was calculated using the continuous nucleosynthesis model. The uranium content of the Bruderheim meteorite was determined. The average of three determinations gave a value of 6 ppB. This was smaller by a factor of two than an earlier reported value. However, it is believed that this lower value is more representative of the uranium content of this meteorite. (Dissertation Abstr.)

8231 X-RAY FLUORESCENCE ANALYSIS OF CHONDRITIC METEORITES. Yates, Ann Marie. Tempe, Ariz., Arizona State Univ., 1966. 91p.

Thesis.

Analysis of samples of each of the chondrite types (carbonaceous, olivine-hypersthene, olivine-bronzite, and enstatite) for the elements chromium, manganese, and iron, using the technique of x-ray fluorescence was investigated. Standard samples of approximate chondrite composition were prepared and used to set up calibration curves relating the intensity of the fluorescent radiation to the amount of a particular element present in the sample. Using these curves, 39 chondritic meteorites (8 carbonaceous, 15 olivine–hypersthene, 12 olivine–bronzite, and 4 enstatite) were analyzed for these three elements. The variation of the chromium and manganese abundances among individual members of the carbonaceous chondrites showed an inverse relationship, i.e., as one increased, the other decreased. This same type of behavior was exhibited for iron and manganese. The chromium–iron variations followed a direct relationship for these meteorites. Both the olivine–hypersthene and the olivine–bronzite chondrites showed direct relationships between manganese and chromium and between iron and chromium. Comparison of the abundances of chromium, manganese, and iron in the different chondrite types indicated that there was fractionation of chromium and iron between the olivine–hypersthene and the olivine–bronzite chondrites, the former being depleted in these two elements. Two possible explanations for this fractionation are offered: selective volatilization of an element or compound, or preferential incorporation of an element into a specific mineral phase, with subsequent segregation of phases. (Dissertation Abstr.)

Inorganic, Organic, and Physical Chemistry

Refer also to abstracts 8366, 8812, 9498, and 10162.

8232 (ANL–7232) GRAIN-BOUNDARY MIGRATION IN POTASSIUM CHLORIDE BICRYSTALS. Final Report, Metallurgy Program 9,6,11. Gibbon, C. F. (Argonne National Lab., Ill.). Aug. 1966. Contract W-31-109-eng-38. 21p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Boundary migration in melt-grown bicrystals of KCl containing pure twist boundaries was studied. A technique for investigating boundary mobility is outlined and applied. An unusually high activation energy, 4 to 6 eV, was found for movement of the twist boundaries. A related computation of twist-boundary energies in the rigid-lattice approximation indicated that the energy is insensitive to boundary misorientation in this approximation. (auth)

8233 (IA–1078) LABORATORY APPARATUS FOR THE INVESTIGATION OF SPRAY REACTIONS WITH THE AID OF RADIOACTIVE TRACERS. Foa, E.; Konigsbuch, M.; Lask, S.; Schachter, O.; Stuhl, Z. (Israel Atomic Energy Commission, Yavne. Soreq Nuclear Research Center). Jan. 1966. 9p. Dep. mn.

An apparatus is described, which was built for studying the reactions occurring in a stationary drop. Single droplets of salts

labeled with a suitable radioisotope are heated in a current of gas. It is possible to measure the change in the activity of the droplet and/or of the escaping gases, which are absorbed. The apparatus permits the study of the influence on reaction kinetics of temperature; drop size; the flow-rate, composition and humidity of the gases; and the concentration of the solutions. (auth)

8234 (IS-T-123) CORRELATION OF THERMODYNAMIC DATA WITH BINARY EUTECTIC-TYPE PHASE DIAGRAMS. Simmons, Michael Fred (Ames Lab., Iowa). Nov. 1966. Contract W-7405-eng-42. 92p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Thesis.

An evaluation has been made of various empirical equations in order to determine their feasibility in describing thermodynamic properties of salt and metal systems. Computer programs have been written and employed for the determination of parameters in the empirical equations. The systems to which the empirical equations were applied are KCl–LiCl, LiCl–RbCl, AgCl–RbCl, AgCl–KCl, Bi–Cd, and Cd–Zn. These systems were chosen because they are simple binary eutectic systems and because necessary thermodynamic data for the pure components and enthalpy of mixing data are available for each of them. Comparison of empirical with experimental enthalpy of mixing data was the primary basis for evaluation. Of the empirical equations considered in this investigation, an equation of the form $\Delta F_i^{xs} = (a + bN_i^n)(1 - N_i)^2$, where $a = \alpha + \beta T$ and $b = \alpha' + \beta' T$, was found to be the most applicable. A method for determining the parameters a, b, and n based upon minimum relative standard deviation in the α, β, α', and β' parameters and involving ΔS_i^{xs} and $\Delta \bar{H}_i$ quantities appeared to be the best approach for future investigations. (auth)

8235 (JINR-P6-3076) OPYTY PO KHIMII ELEMENTA 102. I. ADSORBTSIYA KHLORIDA 102-GO ELEMENTA IZ GAZOVOI FAZY. (Experiments on Chemical Properties of Element 102. I. Chloride Adsorption of Element 102 from Gas Phase). Chuburkov, Yu. T.; Tsaletka, R.; Shalaevskii, M. R.; Zvara, I. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Reactions). 1966. 13p. (In Russian). Dep. mn.

Chemical properties of element 102 were investigated. The adsorption properties of Tb, Cf, Fm, and $^{256}102$ chlorides were compared under conditions used for chemical identification of element 104. The adsorption properties of the gaseous element 102 chloride on solids are shown to be similar to those of the chlorides of elements of group III. A sharp difference in volatility between the chlorides of elements 102 and 104 was confirmed. (auth)

8236 (LA-DC-8266) THERMODYNAMIC PROPERTIES OF PLUTONIUM OXIDES. Mulford, R. N. R.; Holley, C. E. Jr. (Los Alamos Scientific Lab., N. Mex.). [1966]. Contract W-7405-eng-36. 41p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Thermodynamic data are given for plutonium dioxides and the phase diagram is given for the Pu–O system. A close analogy is drawn between the plutonium oxides and the rare earth oxides. Established structures for the plutonium oxides are also discussed. (P.C.H.)

8237 (ORO-3518-1) ELECTROCHEMICAL STUDIES IN MOLTEN FLUORIDES AND OTHER HALIDES. Progress Report, April 1, 1966–March 31, 1967. Mamantov, Glev (Tennessee Univ., Knoxville). Jan. 5, 1967. Contract AT(40-1)-3518. 5p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

EMF and electrode kinetics measurements on the Ni/Ni(II) couple in molten LiF–NaF–KF (46.5–11.5–42 mole %) and LiF–BeF_2–ZrF_4 (65.6–29.4–5.0 mole %) have been performed. The results obtained resulted in a practical reference electrode for molten fluoride compositions. Voltammetric studies of negative oxidation states of bismuth in molten halides will be resumed after the modification of the dry box. A multipurpose electroanalytical instrument for molten salt studies is under construction. (auth)

8238 (KFP-770) ANNOTATED BIBLIOGRAPHY OF THE CHEMISTRY AND PHYSICS OF AMERICIUM. Miller, H. W. (Dow Chemical Co., Golden, Colo. Rocky Flats Div.). Dec. 5, 1966. Contract AT(29-1)-1106. 70p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Four hundred and eighty-two references on americium are presented covering the period to 1965. Most of the information was obtained from Chemical Abstracts and Nuclear Science Abstracts. The abstracts are grouped in categories under chemistry and physics. Author and subject indexes are provided. (M.C.G.)

8239 (TRG-Report-1344) LIMITS FOR THE EQUATION OF STATE OF URANIUM DIOXIDE. Robbins, E. J. (United Kingdom Atomic Energy Authority, Risley (England). Reactor Group). Oct. 6, 1966. 18p. Dep. mn. BIS $0.60. HMSO 3s.

The range of values for the critical constants of UO_2 have been estimated from the low-temperature vapor pressure and specific heat data using the principle of corresponding states. The critical temperature lies within the limits 5500 and 10,000°K, and the critical pressure and volume vary by a similar large value. From this, limits for the equation of state have been derived in the form of pressure-energy and temperature-energy relations as required for the calculation of the energy release in a hypothetical reactor core melt-down. (auth)

8240 (UCRL-50134) FRICTION AND WEAR OF EXPLOSIVE MATERIALS. Hoge, K. G. (California Univ., Livermore. Lawrence Radiation Lab.). Sept. 1, 1966. Contract W-7405-eng-48. 28p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The frictional behavior of various explosive materials, both plastic-bonded and polycrystalline, is discussed. Test data are presented for explosive material sliding on various metallic surfaces and on itself. Surface finishes of 16, 32, and 125 μin. rms were tested. Sliding velocity was varied from 0.001 to 2500 in./min and normal pressure from 125 to about 2500 psi. Of the explosive materials tested, plastic-bonded explosives were found to have a considerably higher coefficient of friction than polycrystalline explosives. The plastic-bonded explosives also showed some viscoelastic or time-dependent effects. Some of the basic theoretical approaches to friction are discussed. Because explosives are generally quite soft, a considerable amount of wear accompanies friction. Therefore, a model for wear was formulated, which accounts for wear during short sliding distances. The contribution of friction and wear to mechanical ignition of explosives was also analyzed. (auth)

8241 (LA-tr-66-70) INTERACTION OF PENTACHLORIDE OF NIOBIUM WITH OXYGEN. Ketov, A. N.; Kolesov, I. M. Translated by A. D. Cernicek (Los Alamos Scientific Lab., N. Mex.), from Izv. Vyssh. Ucheb. Zaved., Tsvetn. Met., 9: No. 3, 77-80(1966). 8p. Dep. mn. JCL $1.10 fs, $0.80 mf.

The reactions between $NbCl_5$ and oxygen were observed at temperatures above the melting point of the chloride. Up to 600°C the process took place with the formation, basically, of $NbOCl_3$, and above 600°C, of $NbOCl_3$ and Nb_2O_5. The increase in the content of oxygen in gas phase did not change the nature of the reaction, but the degree of transformation in this case increased. The presence of chlorine in gas phase reduced the average velocity of the reaction. (auth)

8242 VIBRATION SPECTRUM AND MOLECULAR STRUCTURE OF SOLID URANIUM HEXAFLUORIDE. Bougon, Roland; Rigny, Paul (Service de Documentation, Saclay, Gif-sur-Yvette, France). Compt. Rend., Ser. C, 263: 1321-4(Nov. 28, 1966). (In French).

The vibration spectra of UF_6 confirmed the essentially tetragonal deformation observed by other methods and revealed a slight decrease of symmetry with respect to the D_{4h} group predicted for this deformation. (tr-auth)

8243 STUDY ON PROPERTIES OF THORIUM CHLORIDE. II. ON THE NEW PHASE OF THORIUM TETRACHLORIDE. Takeuchi, Sakae (Tohoku Univ., Sendai); Obata, Naomi. Nippon Kinzoku Gakkai, 30: 946-52(1966). (In Japanese).

Vacuum sublimation of $ThCl_4$ was carried out in order to prepare anhydrous chloride. Properties of the sublimation product and the process conditions were investigated. According to the chemical analysis and melting point measurement, the product was $ThCl_4$, but its x-ray diffraction pattern was quite different from that of the body-centered tetragonal structure formerly confirmed as the crystal structure of $ThCl_4$. Results proved that the known tetragonal phase $ThCl_4$(I) may be regarded as hydrated chloride, and the newly-found phase $ThCl_4$(II) to be anhydrous chloride. On vacuum heating of $ThCl_4$(I), released gas, and solid residue, due to dehydration, and hydrolysis were observed. $ThCl_4$(II) was free from such behavior. In spite of vacuum sublimation, the product was again $ThCl_4$(I) if the released gas from starting chloride was not effectively evacuated. $ThCl_4$(II) could only be prepared by vacuum sublimation under highly dried atmosphere. The diffraction data of $ThCl_4$(II) suggested its crystal structure to be of the orthorhombic system. The lattice constants obtained were a = 11.18, b = 5.93, and c = 9.09Å. The tetragonal data previously known was obtained by using samples prepared by sublimation in a glass capillary, where a highly dried atmosphere could hardly be attained and probably the product was nothing but hydrated $ThCl_4$(I). (auth)

8244 STUDY ON PROPERTIES OF THORIUM CHLORIDE. I. ON ANOMALOUS BEHAVIORS OF BODY-CENTERED TETRAGONAL $ThCl_4$ AT HIGHER TEMPERATURE. Takeuchi, Sakae; Obata, Naomi (Tohoku Univ., Sendai). Nippon Kinzoku Gakkai, 30: 941-6(1966). (In Japanese).

Properties of $ThCl_4$ were studied by means of x-ray powder

diffraction, pressure measurement by the Burdon gauge, and gravimetric analysis by a thermobalance. To prevent the hygroscopic chloride from hydration, all samples were treated in dry atmosphere. The x-ray pattern of $ThCl_4$ powder prepared by chlorination showed a body-centered tetragonal type, in good agreement with the known structure as anhydrous chloride. But in the case of the vapor pressure measurement below 900°C, a markedly irreversible change in pressure was observed on heating and cooling, and retained gas of considerable pressure was found even at room temperature. On gravimetric analysis of tetrachloride in vacuum, a weight loss of 6 to 10% was seen below 400°C, where sublimation of chloride was scarcely observed. After sublimation proceeded above 500°C, the weight loss finally ceased and an insoluble residue was formed. Moreover, the gas release of H_2O and HCl, and the formation of $ThOCl_2$ and ThO_2 were confirmed in the course of heating the $ThCl_4$ powder in vacuum. It is considered from these results that body-centered tetragonal $ThCl_4$ is not of the anhydrous but the hydrated phase containing a considerable amount of H_2O in the crystalline state. Anomalous behaviors of $ThCl_4$ can be attributed to dehydration and hydrolysis. The phase of $ThOCl_2$ was identified and its x-ray diffraction data were established. (auth)

8245 CERTAIN PROPERTIES OF URANIUM PENTOXIDE. Kozhina, I. I.; Osipova, V. V.; Solntsev, V. M.; Tolkachev, S. S. Vestn. Leningr. Univ., Ser. Fiz. Khim., No. 1, 129-32(1966). (In Russian).

The dimensions of the hexagonal cell of U_2O_5 were measured and the thermal stability of U_2O_5 was determined. The hexagonal cell size was established: a = 6.814 ± 0.001 kX and c = 4.118 ± 0.001 kX. The composition of the hexagonal phase of U_2O_5 obtained at low temperatures varied within the range $UO_{2.50}$ to $UO_{2.64}$. U_2O_5 was disproportionated at temperatures above 145°C to 2 phases: hexagonal and cubic. At temperatures of 145 to 170°C hexagonal U_3O_{8-x} and cubic UO_{2+y} are formed; and at 800 to 1000°C, hexagonal U_3O_{8-x} and cubic U_4O_9, a = 5.43 ± 0.01 Å are formed. (ATD)

8246 PLUTONYL BEHAVIOR IN HYDROCHLORIC AND SULFURIC SOLUTIONS. Pozharskii, B. G. Radiokhimiya, 8: 277-85(1966). (In Russian).

The complex formation of plutonyl in hydrochloric and sulfuric acids, and aqueous solutions containing ammonium sulfate was investigated. Complexing in plutonyl solutions proceeded by sharper steps than in corresponding uranyl solutions. Nitrate complexes, having a principally ionic character, differed the most significantly. The differences between the complex compounds in the composition of which anions and double salts appear were considered. In complex compounds all anions are coordinated near the central atom-complexing agent, and cations are added in quantities necessary for the formation of electroneutral compounds. In double salts the fraction of anions is coordinated near the central atom-complexing agent, and the remaining fraction enters in the external sphere of the complex. The stability of the plutonyl during storage of its hydrochloric acid and sulfuric acid solutions, as well as the aqueous solutions of plutonyl containing varying quantities of ammonium sulfate, is discussed. (J.G.B.)

8247 RELAXATION PROCESSES DURING COMPLEX FORMATION. I. COPPER AND AMERICIUM CHLORIDES IN AQUEOUS SOLUTIONS. Vdovenko, V. M.; Kolokoltsov, V. B.; Stebunov, O. B. Radiokhimiya, 8: 286-90(1966). (In Russian).

A simple relation, connecting the experimentally determined relative velocity of relaxation of the solution with the parameters of complex formation, was derived. A method for calculating the effects of macroviscosity is proposed. The method makes it possible to separate from all combinations of the relaxation processes only that part which was determined by its self-complex formation. The stability constants and relaxation efficiency constants of the chloride complexes of copper and americium were determined by the methods proposed. The values of the stability constant agree well with the literature data. (tr-auth)

8248 PARTICLE CHARGE MAGNITUDES DETERMINED BY MEANS OF SWELLING IONITES. I. Komarov, E. V. Radiokhimiya, 8: 290-5(1966). (In Russian).

The equation of the ion exchange isotherms, complicated with complex formation, was determined. The analysis of this equation for the purpose of determining particle charge showed that in cases with complex formation the size characterized neither the mean particle charge in the ionite phase nor the mean particle charge in solution and depends on the exchange group concentration in the ionite phase. (tr-auth)

8249 MECHANISM OF SORPTION OF NITROSORUTHENIUM NITRATE COMPLEXES ON ION EXCHANGE RESINS. Nikolskii, B. P.; Ilenko, E. I. Radiokhimiya, 8: 296-304(1966). (In Russian).

The mechanism of sorption of the nitrate complexes of nitrosoruthenium on ion exchange resins in the pH range from 1 to 11 was found to be sharply distinguished from pure ion exchange processes. The nearest to ion exchange process was the fast sorption on resin of the strong acid type or strong base type. The specificity of the sorption was connected with absorption of the hydrolyzed form of the nitrate complexes of the nitrosoruthenium and with processes of further hydrolysis of the ruthenium in the adsorbed state, and in some cases, possibly with the specific interaction of the ruthenium with resins with formation of complex compounds. The speed of the sorption process was determined by the speed of the chemical reaction, occurring in the resin phase, both at the moment of sorption and after sorption. (tr-auth)

8250 SOME EXPANSION OF THE RELATIVE ABSORPTION THEORY WITH HEXAVALENT URANIUM IN ACETO-NITRATE SOLUTIONS USED AS AN EXAMPLE. Paramonova, V. I.; Kolychev, V. B. Radiokhimiya, 8: 304-17(1966). (In Russian).

The basic aspects of the method of relative adsorption were examined critically and attempts were made by means of the introduction of suitable corrections to expand the utilization of this method to macroquantities of the element studied. The adsorption of U^{6+} on KU-2 cationite was investigated and the instability constants of uranyl acetate complexes in the form $[UO_2Ac]^+$, $[UO_2Ac_2]^0$, and $[UO_2Ac_3]^-$ were calculated. The adsorption of U^{6+} with the anionite ED-1011 was studied. Experimental data led to the conclusion that under the conditions used (pH ≅ 3 to 5 and C_{Ac} ≅ 0.05 to 0.75M), except for the acetate complex formation, the hydrolysis of the uranyl acetate complexes occurs. (tr-auth)

8251 STUDIES OF MUTUAL SOLUBILITY IN THE $UO_2(NO_3)_2$–$(C_2H_5)_2O$–D_2O SYSTEM AT THE SEPARATION REGION AT 25 DEG C. Vdovenko, V. M.; Legin, E. K. Radiokhimiya, 8: 317-23(1966). (In Russian).

The mutual solubility in the $UO_2(NO_3)_2$–D_2O–$(C_2H_5)_2O$ system was investigated in the separation region at 25°C. It was discovered that the distribution coefficient of uranyl nitrate between heavy water and ether is larger than in analogous systems with H_2O. The solubility of $UO_2(NO_3)_2 \cdot 6H_2O$ in D_2O is 11% less than the solubility of $UO_2(NO_3)_2 \cdot 6H_2O$ in H_2O. The observed isotope effects cause a weakening of the ion hydration in D_2O because of the high structuring of the heavy water. A qualitative explanation of the observed phenomena was given from the thermodynamic and molecular-kinetic viewpoint. (tr-auth)

8252 DIFFUSION OF IONS AND WATER STRUCTURE. Vdovenko, V. M.; Gurikov, Yu. V.; Legin, E. K. Radiokhimiya, 8: 323-30(1966). (In Russian).

The results from data on equivalent electroconductivity at infinite dilutions at two temperatures made it possible to calculate the potential barriers governed by molecular exchange in the hydrate film of ions. Near each ion behind the layer of primary hydration where the water molecule is firmly bound with the ions, a range of destroyed structures exists where the potential barriers, dividing the neighboring equilibrium state, are lower than in pure water. The ions K^+, Cs^+, NH_4^+, Cl^-, and I^- as a rule increase the mobility of the surrounding H_2O molecules and, therefore, are negatively hydrated. (tr-auth)

8253 ISOTOPIC EXCHANGE OF HOLMIUM IN THE Ho^{3+}–Ho(EDTA)-SYSTEM. Makashev, Yu. A.; Makasheva, I. E.; Melnikov, V. A. Radiokhimiya, 8: 371-3(1966). (In Russian).

The effects of pH, concentration of HoY^- complex, and concentration of unbound Ho on the isotopic exchange of Ho in the Ho^{3+}–$Ho(EDTA)^-$ system were investigated. The results are graphed. It was concluded that the velocity of the isotopic exchange in complex compounds of Ho with EDTA does not interfere with the use of this compound for isotopic enrichment by the Szillard-Chalmers method. (J.S.R.)

8254 ELECTROMIGRATION OF ^{22}Na, ^{42}K, ^{86}Rb, AND ^{134}Cs IN MELTED POTASSIUM, SODIUM, AND LITHIUM NITRATES. Shvedov, V. P.; Ivanov, I. A. Radiokhimiya, 8: 373-5(1966). (In Russian).

It was established that the migration of ^{22}Na, ^{42}K, ^{86}Rb, and ^{134}Cs in melted potassium, sodium, and lithium nitrates depends on background fusion. The transfer number of cations in the fused nitrates, determined by the labeled atom method, agreed with the transfer number obtained without use of radioactive indicator. The transfer number obtained did not depend on the experimental parameters (current intensity and quantity of electricity passed by the melt and duration of the electrolysis) and the diaphragm materials. (tr-auth)

8255 INFLUENCE OF THE CONJUGATION ON THE STABILITY OF THE PRIMARY MOLECULAR ION. Nefedov, V. D.;

Grachev, S. A.; Gracheva, L. M.; Petrov, L. N. Radiokhimiya, 8: 376-9(1966). (In Russian).

An attempt was made to demonstrate the stability of primary molecular ions as a function of the conjugation of the initial molecular system and of the degree of conjugation of the isoelectron primary molecular ions. Coplanarity is the principal condition of coupling with aromatic nuclei. The results of previous investigations on molecular spectra and photoionization of various aromatic derivatives of trivalent P, As, Sb, and Bi showed that such systems are conjugated. However, the conjugation is affected by spatial coplanarity difficulties. This factor was considered in studies of changes taking place in ^{210}Bi decay in mesityl derivatives of the trivalent bismuths $[1,3,5\text{-}(CH_3)_3C_6H_2]_3Bi(RaE)$ which in ortho position to each Po–C bond has two methyl groups. The presence of six methyl substitutes near the control atom disrupts the coplanarity of the system and reduces its conjugation and also the yield of products of stabilized primary molecular ions. The results of chromatographic analysis of the spectrum of polonium organic compounds formed in ^{210}Bi β decay in trimesityl bismuth showed that the yield of stabilized primary molecular ions R_3PoX is sharply reduced (~35%) in comparison with the yields of derivatives of other organic compounds. (R.V.J.)

8256 ADSORPTION OF CURIUM ON THE POLISHED PLATINUM SURFACE. Samartseva, A. G. Radiokhimiya, 8: 269-77 (1966). (In Russian).

The adsorption of $^{242}Cm(10^{-12}\underline{M})$ on the surface of platinum in HNO_3 solution was investigated as a function of the hydrogen ion concentration in the range from 10^{-1} to 10^{-12} $\underline{M}$. It was found that up to pH = 3 the sorption was insignificant (1 to 2%), whereas at pH = 3 to 4, the curium adsorption on platinum sharply increased (98 to 100%). The sorption maximum was extended up to pH = 4 to 6, after which the sorption of the radioactive element was decreased by 10%. The sorption of curium on platinum from solutions, first aged for 24 hrs in glassware, was decreased for all pH values by 25 to 30% in comparison with the adsorption from freshly prepared solutions. The adsorption of ^{242}Cm on platinum in the absence of silicic acid from freshly prepared solutions and from solutions first aged continuously in fluoride sheet dishes did not differ. From the data obtained it was concluded that the state of the radioactive element in pure solutions at every pH value remains constant in the time limits indicated. The adsorption of ^{242}Cm on platinum in the presence of foreign ions (La^{3+}, K^+) and H_2O_2 was also studied. Lanthanum decreased the sorption of Cm in range of the maximum by 50 to 60% and K increased the sorption of Cm in the area of high pH values. In the presence of H_2O_2 the sorption of Cm on platinum did not change up to pH = 7. At pH > 8 with increase of the concentration of H_2O_2 up to 0.5 $\underline{M}$ in the solution, the sorption of curium on platinum increased by 100%. On the basis of the data obtained a new quantitative method for the separation of indicator quantities of carrier-free curium on platinum was developed. (tr-auth)

8257 CONDUCTANCE TITRATIONS IN DILUTE OLEUM AND THE DISSOCIATION CONSTANT OF DISULFURIC ACID IN SOLVENT SULFURIC ACID. Mountford, G. A.; Wyatt, P. A. H. (Univ. of Sheffield, Eng.). Trans. Faraday Soc., 62: 3201-16 (Nov. 1966).

Conductance titrations of oleums with potassium hydrogen (or deuterium) sulphate were carried out at 25 and 69° in both the hydrogen and the deuterium sulphuric acid systems. A single experiment was also carried out at 11° with the hydrogen system. The conductance at the minimum in such titrations was greater than that of the pure acid and indicates that the hydrogen (deuterium) disulphate ion has an appreciable mobility, which must be taken into account in the analysis of the results to determine K_a. In the H_2SO_4 system, the K_a of $H_2S_2O_7$ was 0.025 mole (kg solv)$^{-1}$ at 25° and 0.029 at 69°, implying ΔH_a = 0.7 kcal mole^{-1}; the single experiment at 11° gave 0.022, confirming the small temperature dependence. In the D_2SO_4 system, the K_a of $D_2S_2O_7$ was 0.0060 (same units) at 25° and 0.0074 at 69°, implying ΔH_a = 1.0 kcal mole^{-1}. The sensitivity of these numbers to the choice of other constants is examined, and simple rules are given for estimating the effects of any subsequent adjustments in these constants. (auth)

8258 STUDIES OF HYDROGEN HELD BY SOLIDS. PART II. INTERACTION OF SIMPLE OLEFINS AND PYRIDINE WITH DECATIONATED ZEOLITES. Liengme, Bernard V.; Hall, W. Keith (Mellon Inst., Pittsburgh). Trans. Faraday Soc., 62: 3229-43 (Nov. 1966).

Three OH stretching bands, with maxima at about 3745, 3650, and 3545 cm^{-1}, were present in infrared spectra of decationated X- and Y-type zeolites. Pyridine reacted with the 3650 cm^{-1} species to form pyridinium ion. This band underwent a hydrogen bonding shift when ethylene was adsorbed at room temperature, indicating a strong physical adsorption which was quantitatively and rapidly reversible on raising or lowering the pressure. No exchange occurred between C_2H_4 and the OD groups of an exhaustively deuterated zeolite. The hydrogen bonding shift from 3650 to 3300 cm^{-1} was identical when C_2D_4 was substituted for C_2H_4. The 3745 and 3545 cm^{-1} bands were not noticeably altered by the adsorption, at least in the pressure region where the 3650 cm^{-1} band was affected. Adsorption isotherms, calculated from the spectra, could be superimposed on those determined by volumetric techniques. Both were close to Langmuir-type but showed evidence of a superimposed non-selective adsorption at higher pressures. Ethylene may also adsorb, via a charge transfer interaction, on the residual Na^+ ions of the zeolite. At about 500 torr, the total adsorption of C_2H_4 was about 30% greater than the available zeolite hydroxyl groups. It was inferred that the strongest interaction was with the acidic hydroxyl groups and that, at low pressures, most of the adsorbed C_2H_4 was hydrogen-bonded to these. In the CH bending and stretching regions, only the Q-branch of the spectra of the gaseous molecules appeared, indicating that molecular rotation was hindered in the adsorbed state. Qualitatively similar results were obtained with C_3H_8. The hydrogen-bonding shift was greater by about 100 cm^{-1}, however, and the adsorption was not entirely reversible. Moreover, the irreversible portion increased with time, and products stemming from polymerized olefin could be recovered; also, C_3D_8 exchanged with the OH groups of the 3650 and 3545 cm^{-1} bands, but not with those of the 3745 cm^{-1} band. Preliminary results for these substrates adsorbed on dehydroxylated, decationated zeolites are given. (auth)

8259 SODIUM AMALGAM CASE HARDENING OF MICROQUANTITIES OF CARRIER-FREE RARE EARTHS IN ACETATE SOLUTIONS. Novgorodov, A. F.; Khalkin, V. A.; Wang, Chuang-pin. Radiokhimiya, 8: 347-52(1966). (In Russian).

Systematic studies were made on the case hardening process of ultra-small quantities of rare earth elements. The degree of case hardening of carrier-free isotopes from La to Eu and Yb as a function of total concentration of acetate and sodium chloride is tabulated. The case hardening of the light lanthanides and ytterbium was suppressed by the presence of weighable quantities of elements which did not case harden. (tr-auth)

8260 DIFFUSION OF $H_2{}^{18}O$ MOLECULES IN CONCENTRATED AQUEOUS SOLUTIONS OF SOME SALTS. Tamas, Jozsef; Ujszaszy, Kalman (Research Lab. for Chemical Structures, Budapest). Magyar Kem. Foly, 72: 447-53(Oct. 1966). (In Hungarian).

Diffusion coefficients for $H_2{}^{18}O$ were determined in KCl, $CaCl_2$, NaI, CsI, and CsF solutions at room temperature at various concentrations with the aid of the open-end capillary method. The molecules' effect was the sum of the ions' effect present; the effect of viscosity was in correlation with the theory of Podolsky, R. J., (J. Amer. Chem. Soc., 80: 4442(1958)). An equation derived on the basis of the Hartley-Crank flow-medium model (Trans. Faraday Soc., 45: 801(1949)) described accurately the relationship between the isotopic diffusion coefficients of the components and the differential diffusion coefficient of the salt. (JPRS)

8261 INFRARED SPECTRA OF THE WATER CONTAINED IN URANYL NITRATE HYDRATES. Karyakin, A. V.; Nemodruk, A. A.; Petrov, A. V.; Bezrogova, E. V. (Vernadskii Inst. of Geochemistry and Analytical Chemistry, Academy of Sciences, USSR). Dokl. Akad. Nauk SSSR, 168: 817-20(June 1, 1966). (In Russian).

The last two molecules of water in the uranyl nitrate hydrates are retained tenaciously. The dihydrate and trihydrate were prepared from the hexahydrate of uranyl nitrate by drying over 63 and 93% sulfuric acid respectively, and infrared absorption spectra in purified tributyl phosphate (TBP) were taken at 3000 to 4000 cm^{-1}. The differential infrared absorption spectrum of the dihydrate with respect to anhydrous TBP showed two water absorption bands with maxima at 3140 and 3660 cm^{-1}. This behavior indicated that water followed the uranyl ion on extraction with TBP. The difference in synphase and antiphase oscillations in the spectrum indicated unsymmetrical loading of the oxygen atoms. It was concluded from the data that both water molecules in uranyl nitrate dihydrate are each coordinated by means of its own oxygen atom to the uranium atom, and at the same time, by means of one of the hydrogen atoms, the water atoms are coordinated to the oxygen of the uranyl group with the formation of a very strong hydrogen bond of 9.5 kcal/mole. (TTT)

8262 URANIUM MONOSULPHIDE CRYSTALLIZED FROM SULPHURATED URANIUM MELT. Itoh, Hikaru (Mitsubishi Metal Mining Co., Ltd., Omiya, Japan); Akimoto, Yumi; Ishii, Bumpei. J. Nucl. Sci. Technol. (Tokyo), 3: 497-8(Nov. 1966).

The crystallization of US from Mo–U alloys reacted with H_2S in an argon plasma flame is discussed. After extinction of the flame, the sample was allowed to cool. The sample was then sliced, pol-

ished, and etched with nitric acid at ~50°C. X-ray diffractography of the sample showed strong lines of US. The crystals were dendritic or plate-like in shape. Electron-probe analysis indicated that these crystals formed while the matrix was still molten. (M.C.G.)

8263 THE CRYSTAL STRUCTURE OF URANIUM IMIDE CHLORIDE U(NH)Cl. Berthold, H. J.; Knecht, H. (Univ., Mainz). Z. Anorg. Allg. Chem., 348: 50-7(Nov. 1966). (In German).

Uranium imido chloride, U(NH)Cl, obtained by high-temperature ammonolysis of UCl_4 and UCl_3 crystallizes with the PbFCl-layer structure (space group D_{4h}^7-$P4/nmm$) with two molecules in the tetragonal unit cell. The lattice constants are a = 3.972 ± 0.05 and c = 6.180 ± 0.010 Å. Intensity calculations gave for uranium the parameter U = 0.168 ± 0.001 and for chlorine the parameter V = 0.63 ± 0.005. The much smaller effective radius of the NH^{2-} ions in U(NH)Cl in comparison with the radius in other salt-like imides suggests that the NH^{2-} groups in U(NH)Cl are restricted from free rotation by hydrogen-bond formation. Shortest distances are: $NH^{2-} - NH^{2-} = 2.81$; $U^{3+} - 4NH^{2-} = 2.29$; $U^{3+} - 4Cl^{-} = 3.13$; $U^{3+} - 1Cl^{-} = 3.15$; U − U = 3.62; and Cl − Cl = 3.32 Å. (auth)

8264 AUTOMATIC AND COULOMETRIC TITRATIONS IN STUDIES OF CHEMICAL KINETICS. III. EVALUATION OF THE RATE CONSTANT FOR THE DISPROPORTIONATION OF URANIUM(V) BY AUTOMATIC AMPEROMETRIC TITRATIONS OF URANIUM(VI) WITH CHROMIUM(II). Carr, Peter W.; Meites, Louis (Polytechnic Inst. of Brooklyn). J. Electroanal. Chem., 12: 373-84(Nov.-Dec. 1966).

The rate constants for the disproportionation of uranium(V) in perchlorate solutions having hydrogen-ion concentrations between 0.01 and 1.0M were evaluated by adding a solution of chromium(II) at a constant rate to one of uranium(VI), employing a vibrating dropping mercury electrode to follow the variation of the concentration of either uranium(VI) or uranium(V). The resulting values are in acceptable agreement with those obtained by other techniques. (auth)

8265 STUDY OF THE DISTRIBUTION OF URANIUM AND IRON CATIONS IN THE MIXED OXIDE WITH THE FORMULA $Sr_3UFe_2O_9$. Berthon, Jacques; Ropars, Claude; Bernier, Jean-Claude; Poix, Paul (Univ., Paris, Orsay, France). Compt. Rend., Ser. C, 263: 1304-5(Nov. 21, 1966). (In French).

A crystallographic study of the mixed oxide $Sr_3UFe_2O_{9-\epsilon}$ led to the following distribution: $Sr_3(Fe_4)(Fe_xU_y)O_{24-x}(O \leq X \leq 0.3)$. The iron and uranium are ordered on the two sites 4a and 4b of the crystalline lattice defined by the space group F m 3 m. (tr-auth)

8266 VARIATION WITH TEMPERATURE OF THE VELOCITY OF U HYDRIDATION. Amilhat-Caralp, Francoise; Casahoursat, Lucien; Destriau, Michel (Univ., Bordeaux). Bull. Soc. Chim. France, No. 11, 3594-8(Nov. 1966). (In French).

The velocity of U hydridation was a maximum at a temperature slightly above 200°C in the case of solid metal and close to room temperature for metal divided by hydridations and dehydridations. The mechanism, a nucleation-type at low temperature and for the massive metal, evolved toward a diffusion mechanism by elevation of the temperature or division of the metal. (tr-auth)

8267 A STUDY OF THE URANYL NITRATE–o-AMINOPHENOL-p-SULFONIC ACID SYSTEM. Mavrodin, Maria (Institut de Chimie Inorganique, Bucharest). Rev. Roum. Chim., 11: 1159-73(Oct. 1966). (In French).

Spectrophotometric, conductometric, and pH studies were made on the reaction between uranyl nitrate and o-aminophenol-p-sulfonic acid(4-hydroxy-metanilic acid). A quantitative study of the system indicated the formation of three complexes, stable at different pH levels, and which corresponded to the ratios of formation: UO_2^{2+} : R = 1 : 1 (pH 2.7); 1 : 2 (pH = 3.5 to 5); 1 : 1 (pH = 7 to 9). The use of o-aminophenol-p-sulfonic acid as a reagent for the spectrophotometric determination of uranium(VI) was also investigated. (tr-auth)

8268 PECULIARITIES OF THE VACUUM-THERMAL METHOD OF PREPARATION AND SOME PROPERTIES OF YTTRIUM AND GADOLINIUM BORIDES. Manelis, R. M.; Meerson, G. A.; Zhuravlev, N. N.; Telyukova, T. M.; Stepanova, A. A.; Gramm, N. V. Porosh. Met., Akad. Nauk Ukr. SSR, No. 11, 77-84(Nov. 1966). (In Russian).

Conditions for obtaining yttrium and gadolinium borides by vacuum-thermal reduction of yttrium and gadolinium oxides by boron was investigated. The conditions for obtaining YB_4, YB_6, YB_{12}, GdB_4, and GdB_6 were worked out. The compounds YB_6, YB_{12}, and GdB_6 were stable in a vacuum up to a temperature of 1700°C. But they dissociated under higher temperatures forming tetraborides and the boron sublimates. A hypothetical state diagram of Gd–B is proposed. Some properties of YB–Gd–B compounds were studied. (auth)

8269 MONOMER-POLYMER EQUILIBRIA OF DEUTERATED α-METHYLSTYRENES. Fetters, Lewis J.; Pummer, Walter J.; Wall, Leo A. (National Bureau of Standards, Washington, D. C.). J. Polym. Sci., Pt. A-1, 4: 3003-11(Dec. 1966).

The equilibria between α-trideuteromethyl-β,β-dideuterostyrene, α-methyl-2,3,4,5,6-pentadeuterostyrene, and perdeutero-α-methylstyrene and their respective polymeric anions in tetrahydrofuran were investigated between 253 and 308°K. The heat and entropy changes were both increased by deuteration of the alkyl group. Qualitatively the effects appear best explained by the premise that a lowering of steric repulsions occurs with deuterium and hence the effective volume for deuterium is less than that for hydrogen. (auth)

8270 PARAMAGNETIC CATALYSIS OF THE ORTHO-PARAHYDROGEN CONVERSION. Nielsen, Svend E.; Dahler, John S. (Univ. of Minnesota, Minneapolis). J. Chem. Phys., 46: 732-44(Jan. 15, 1967).

A theory is presented for the paramagnetic catalysis of ortho-para transitions in molecular hydrogen, deuterium, and tritium. The cause for reaction is taken to be an inhomogeneous magnetic field, originating from a catalyst molecule and operative during the binary collisions of catalyst and reactant species. Formulas for the distorted wave approximation to the cross sections are presented, as are expressions for the specific rates of the associated thermal reactions. Exploratory calculations are performed for the oxygen catalyzed para(L = 0) → ortho(L = 1) transition in hydrogen. With the assumption of a hard-sphere interaction the rates calculated for 77.3 and 86°K are only about 25 to 30% of the experimentally observed rates. (auth)

8271 SURFACE DIFFUSION OF DEUTERIUM AND LIGHT HYDROCARBONS IN MICROPOROUS VYCOR GLASS. Hwang, Sun-Tak; Kammermeyer, Karl (Univ. of Iowa, Iowa City). Sep. Sci., 1: 629-39(1966).

The significance of the surface diffusion of helium through a microporous Vycor glass is emphasized, and the experimental evidence is presented. Permeability data of D_2, CH_4, C_2H_6, and C_3H_8 are reported over a wide temperature range, and the results are analyzed numerically. Comparisons were made for D_2-H_2 and $C_3H_8-CO_2$ systems. Finally, the separation factors for $CO_2-C_3H_8$ and $CH_4-C_3H_8$ systems are discussed. All the experimental work was carried out with porous Vycor glass as the microporous medium. However, there is good reason to believe that the basic findings will hold for any other microporous barrier. Differences will only be a matter of magnitude and will be determined by the adsorption interaction of the respective gas-solid system. (auth)

8272 SERIES SOLUTIONS AND ROTATIONLESS STATES OF THE VIBRATING HYDROGEN MOLECULE ION. Harriss, Donald K. (Univ. of Minnesota, Duluth). J. Chem. Phys., 46: 766-71(Jan. 15, 1967).

The generalized series solution methods for nonseparable Hamiltonians proposed by Frost were investigated. It is shown that for the general case a solution is not possible without explicit evaluation of a minimum number of integrals. The B matrix method is shown to be equivalent to the use of the integral relations, J(f), developed in Hirschfelder's derivation of quantum-mechanical hypervirial theorems. The B matrix method was applied to vibrating H_2^+, HD^+, and D_2^+. (auth)

8273 SPECTRUM OF GASEOUS UCl_4. Morrey, J. R. (Battelle Northwest Labs., Richland, Wash.); Carter, D. G.; Gruber, John B. Contracts AT(45-1)-1830; AT(11-1)-34. J. Chem. Phys., 46: 804-9(Jan. 15, 1967).

The spectra between 4,000 and 23,000 cm^{-1} of gaseous UCl_4 have been obtained for the temperature range 950 to 1250°K. These spectra have been compared with those of single-crystal UCl_4 at 77°K and room temperature. Spectra of solid UCl_4 were obtained over the temperature range 300 to 827°K in order to compare with the gas. In general, the molar absorptivities of the gas are a factor of 10 attenuated over the solid. The energy levels of the gaseous state do not shift appreciably with temperature but, in general, the spectrum of the gas is shifted to the red side of the high-temperature solid spectra. With the exception of a general shift, the spectrum of the vapor is remarkably similar to that of the solid. (auth)

8274 EXCHANGE REACTIONS OF 2.8-eV TRITIUM ATOMS WITH ISOTOPIC MOLECULAR HYDROGEN: H_2, D_2, AND HD. Chou, C. C.; Rowland, F. S. (Univ. of California, Irvine). J. Chem. Phys., 46: 812-13(Jan. 15, 1967).

A series of competitive experiments for exchange of tritium with H_2, D_2, and HD were carried out using 2.8-eV tritium atoms from photolysis of TBr. A much lower isotope effect was observed than in recoil tritium experiments. (M.C.G.)

8275 ON THE EXISTENCE OF A HIGHER VALLENCE OF CURIUM IN SOLUTION. CRITICAL STUDY OF OXIDATION BY OZONE. Pages, Monique; Demichelis, Rene (Institut de Physi-

que Nucleaire, Paris). Compt. Rend., Ser. C, 263: 938-40 (Oct. 17, 1966). (In French).

Experiments were made on the adsorption on anion resin treated with ozone of curium and gadolinium. They show that ozone degrades the anion resin. Therefore, deductions drawn previously on the oxidation of curium to the valence six in solution were shown to be erroneous. (tr-auth)

8276 THERMOGRAVIMETRIC STUDY, DIFFERENTIAL THERMAL ANALYSIS, AND INFRARED ABSORPTION SPECTROGRAPHY OF URANIUM PEROXIDE HYDRATES. Rocchiccioli, Claude (Ecole Nationale Superieure de Chimie, Paris). Compt. Rend., Ser. B, 263: 1061-3(Nov. 7, 1966). (In French).

The infrared absorption spectra of the compounds $UO_4 \cdot 4H_2O$ and $UO_4 \cdot 2H_2O$ were found to be compatible with the peroxide structure. (tr-auth)

8277 INHIBITING ACTION OF SOME SULFUR-CONTAINING MOLECULES ON LIQUID SCINTILLATORS. Serres, P.; Commanay, L.; Guiraud, R.; Teyssier, J. L.; Blanc, D. (Toulouse Univ. Centre de Physique Nucleaire, Toulouse). Int. J. Appl. Radiat. Isotop., 17: 668-70(Dec. 1966). (In French).

The inhibiting action of sulfur, carbon disulfide, and thiophene, and thiophenol on the classic liquid scintillator obtained by the dissolution of 2-5-diphenyl oxazole (PPO) and 1-4-di(2-5)-phenyl oxazolylbenzene (POPOP) toluene was studied. The results showed that with all the sulfur compounds the logarithm of the pulse amplitudes decreased linearly with an increase of concentration. However, the degree of inhibition varies significantly with the nature of the sulfur compound. The inhibition is less for thiophene and most for carbon disulfide and thiophenol. A comparison of the inhibiting action calculated by the Storn Volmer equation and that obtained experimentally showed that this equation is insufficient. (J.S.R.)

8278 FLUORESCENT PROPERTIES OF TRIVALENT RARE EARTHS IN FLUORITE STRUCTURE OXIDES. Linares, Robert C. (Perkin-Elmer Corp., Norwalk, Conn.). J. Opt. Soc. Amer., 56: 1700-3(Dec. 1966).

The fluorescent properties of the trivalent rare earths were studied in the fluorite structure oxides, CeO_2 and ThO_2. In these compounds, the cations occupy sites of cubic symmetry, but the symmetry of the trivalent rare earth depends on the concentration and the manner of charge compensation. The emission spectra, fluorescent lifetimes, and excitation spectra were studied as functions of these variables. Multiple-emission spectra of the trivalent ions were observed which varied with concentration and charge compensation. These changes were attributable to multiple sites for the rare earth under the various conditions. The multiple spectra could be well separated in the case of the $^5D_0$–$^7F_1$ transition of Eu^{3+} in ThO_2 which shows at least three distinct spectra. A twofold enhancement of fluorescent lifetime was found to occur when the rare earth was placed in a predominantly cubic environment. The excitation spectra did not change detectably from those expected from known energy levels, but energy transfer was found to occur from the CeO_2 band edge (~38 000 cm^{-1}) to Eu^{3+}, Sm^{3+}, and Er^{3+}. (auth)

8279 PREPARATION OF URANIUM CARBIDE FROM URANIUM CHLORIDE. Mukaibo, Takashi; Kanno, Masayoshi; Mitamura, Takashi; Yoshihara, Kazuhiro (Tokyo Univ.). J. Nucl. Sci. Technol. (Tokyo), 3: 388-92(Sept. 1966).

A method was developed for the preparation of uranium monocarbide using UCl_4 as starting material. The reaction of UCl_4, Al, and graphite powder mixtures under Ar atmosphere was selected for reasons of availability of material and facility of post-reaction processing. It was confirmed by chemical and x ray analyses that UC was obtained at temperatures between 600 and 1,200°C. The purest UC was obtained at 900°C, and the conversion efficiency of uranium reached a maximum of about 80%. (auth)

8280 EXPERIMENTS ON ADSORPTION OF RADIOACTIVE IODINE VAPOR ON SMALL METALLIC FUME PARTICLES. Takahashi, Kanji (Kyoto Univ.). J. Nucl. Sci. Technol. (Tokyo), 3: 401-3(Sept. 1966).

Molecular iodine vapor was generated and mixed with metallic fumes and the adsorption of iodine vapor on fume particles was evaluated by a method using a diffusion tube. The adsorption rate of vapor on aerosol particles was examined by changing the mixing time of vapor with the particles. No detectable difference of adsorption was found when the mixing period ranged from 5 to 240 sec. Iodine vapor adsorption on metallic fumes increased proportionally to vapor concentrations at both low and high vapor concentrations. The adsorbed amounts were much larger than calculated as monolayer adsorption. (D.H.M.)

8281 MILLIMETER-WAVE ROTATIONAL STARK SPECTRA OF HNCO, DNCO, AND HN_3: DIPOLE-MOMENT CHANGES WITH K. White, Kevin J.; Cook, R. L. (Duke Univ., Durham, N. C.). J. Chem. Phys., 46: 143-51(Jan. 1, 1967).

By employing a parallel-plate semifree-space cell the millimeter-wave rotational Stark spectra of HNCO, DNCO, and HN_3 were observed in the ground vibrational state. Analysis of the Stark effect for the $J = 3 \rightarrow 4$ transitions yields the dipole-moment component along the axis of smallest moment of inertia. For these very slightly asymmetric rotors the dipole moment is observed to decrease with increasing K. For HNCO ($J = 3 \rightarrow 4$), the dipole moments are found to be (Debye units) $K = 0$, $\mu_a = 1.613 \pm 0.002$, $K = 1$, $\mu_a = 1.575 \pm 0.002$, $K = 2$, $\mu_a = 1.540 \pm 0.001$, and $K = 3$, $\mu_a = 1.500 \pm 0.002$; for DNCO ($J = 3 \rightarrow 4$), $K = 1$, $\mu_a = 1.602 \pm 0.003$, and $K = 2$, $\mu_a = 1.580 \pm 0.001$; and for HN_3 ($J = 3 \rightarrow 4$), $K = 1$, $\mu_a = 0.8369 \pm 0.0020$, and $K = 2$, $\mu_a = 0.8247 \pm 0.0002$. Results are discussed in terms of the electronic structures of the molecules. (auth)

8282 MICROWAVE SPECTRUM, STRUCTURE, DIPOLE MOMENT, AND BARRIER TO INTERNAL ROTATION OF PHOSPHORUS TRIFLUORIDE-BORANE. Kuczkowski, R. L.; Lide, David R. Jr. (National Bureau of Standards, Washington, D. C.). J. Chem. Phys., 46: 357-65(Jan. 1, 1967).

The microwave spectrum of several isotopic species of phosphorus trifluoride–borane (F_3PBH_3) was measured and the following structural parameters determined: $d(BH) = 1.207 \pm 0.006$ Å; $d(PF) = 1.538 \pm 0.008$ Å; $d(PB) = 1.836 \pm 0.012$ Å; $\angle HBH = 115°04' \pm 1°$; $\angle FPF = 99°50' \pm 1°$. The dipole moment was evaluated from Stark splittings as 1.64 ± 0.02 D. The vibrational satellite spectrum associated with the excited $\nu_{12}(E)$ and $\nu_6(A_2)$ states for $F_3P^{11}BH_3$ was strongly perturbed and was fitted to the theory for a first-order Coriolis interaction. The analysis of this perturbation and the measurement of the ν_{12} fundamental in the infrared spectrum permitted the inactive torsional fundamental ν_6 to be determined as 197 ± 5 cm^{-1}. This leads to a potential barrier to internal rotation of 3240 ± 150 cal/mole. The enthalpy of dissociation for the reaction $2\ F_3PBH_3 \rightleftharpoons 2\ PF_3 + B_2H_6$ (298°C) was determined as 10.99 kcal. The experimental results are compared with related compounds. (auth)

8283 THE EMISSION SPECTRUM OF THE PD^+ MOLECULE. Narasimham, N. A.; Dixit, M. N. (Atomic Energy Establishment, Trombay, India). Curr. Sci. (India), 36: 1-3(Jan. 5, 1967).

The spectrum of the PD^+ molecule was obtained in a microwave discharge through phosphorus vapor, deuterium, and helium gas. The bands obtained were similar to the emission bands of PH^+. The new emission bands lay at 3683, 3826, and 4086Å. An analysis of their vibrational and rotational structure showed that they were the 1–0, 0–0, and 0–1 bands of PD^+ involving the $^2\Delta$–$^2\Pi$ transition. (D.H.M.)

8284 RESTRICTED ROTATION IN SOLID DEUTEROMETHANES. Hopkins, Harry P. Jr.; Kasper, Jerome V. V.; Pitzer, Kenneth S. (Rice Univ., Houston, Tex.). J. Chem. Phys., 46: 218-20(Jan. 1, 1967). (ORO–2907-8).

The theory of Nagamiya for restricted rotation in solid methane was extended to all of the partially deuterated species and applied to the experimental heat-capacity data of Colwell, Gill, and Morrison, which showed anomalously high values in the range below 4°K. Agreement with these data was obtained for reasonable values of the energy parameters; also the total entropy of each anomaly was predicted. (auth)

8285 EXCITED-STATE PROTON-TRANSFER REACTIONS. A DEUTERIUM ISOTOPE EFFECT ON FLUORESCENCE. Stryer, Lubert (Stanford Univ., Palo Alto, Calif.). J. Amer. Chem. Soc., 88: 5708-12(Dec. 20, 1966).

A large deuterium isotope effect on fluorescence emission spectra and quantum yields was observed in a number of chromophores that contain proton donor groups. In the absence of a proton donor or acceptor group, there was no appreciable isotope effect. When both the protonated (R^*H) and unprotonated (R^{*-}) excited species were fluorescent, the shape of the emission spectrum was different in H_2O and D_2O. This finding was interpreted in terms of an isotope effect on the rate of proton transfer during the excited-state lifetime in the reaction $R^*H + H_2O \rightleftharpoons R^{*-} + H_3O^+$: k_1 forward, k_2 reverse reaction rates. For 2-naphthol, k_1 is 5.29×10^7 in H_2O and 1.31×10^7 in D_2O; k_2 is 5.5×10^{10} in H_2O and 3.5×10^{10} in D_2O. These rate constants account for the larger proportion of R^{*-} emission seen in H_2O compared to D_2O on excitation of RH. For compounds in which R^{*-} was nonfluorescent, the quantum yield was observed to be higher in D_2O than in H_2O, if a proton donor group was present on the chromophore. It was postulated that this isotope effect on quantum yield was due to a slower rate of proton transfer in D_2O to form a nonfluorescent species during the excited-state lifetime. For example, in 5-amino-1-naphthalenesulfonate, the quantum yield was 3.04-fold higher in D_2O. In contrast, the quan-

tum yield of 1-naphthalenesulfonate was the same in H_2O and D_2O. A comparison of the fluorescence properties of a chromophore in H_2O and D_2O should prove useful in determining whether the excited state is involved in proton-transfer reactions. (auth)

8286 ELECTROPHILIC SUBSTITUTION AT SATURATED CARBON. XXVIII. THE STEREOCHEMICAL CAPABILITIES OF VINYL ANIONS. Hunter, D. H.; Cram, Donald J. (Univ. of California, Los Angeles). J. Amer. Chem. Soc., 88: 5765-76 (Dec. 20, 1966).

The base-catalyzed isomerization and hydrogen isotope vinyl exchange of cis- and trans-stilbene, cis- and trans-α,α'-dideuteriostilbene, and cis- and trans-p-nitrostilbene with solvent were studied. Solutions of potassium t-butoxide in t-butyl alcohol, in t-butyl alcohol–tetrahydrofuran, and in t-butyl alcohol–dimethyl sulfoxide, of potassium hydroxide in dimethyl sulfoxide, of dimsylpotassium in dimethyl sulfoxide, and of potassium methoxide in methanol, and in methanol–dimethyl sulfoxide appropriately deuterated or nondeuterated were employed as media. All isotopic exchanges of both of the cis isomers to give cis isomers occurred through vinyl intermediates. Those cis to trans isomerizations carried out in t-butyl alcohol, t-butyl alcohol–tetrahydrofuran, and in dimethyl sulfoxide probably occurred mainly through vinyl anion intermediates. Those isomerizations observed in methanol or dimethyl sulfoxide–methanol mixtures clearly went by an addition–elimination mechanism. The ratio of rate constants (estimated) of isotopic exchange of cis-stilbene to that of isomerization (k_e^c/k_i^c) changed in a systematic manner from 5×10^3 to 0.8 as a t-butyl alcohol medium was enriched in dimethyl sulfoxide. In dimethyl sulfoxide–dimsylpotassium, the isomerization of cis- to trans-stilbene occurred with about 32% retention of the isotopic label, even though an anionic intermediate was involved. In t-butyl alcohol–potassium t-butoxide, the k_e^c/k_i^c for cis-p-nitrostilbene was about unity. In solvents that contained methanol, the isomerization of this system occurred by an addition–elimination mechanism. In both systems, the cis isomers underwent isotopic exchange faster than the trans isomers by one to two powers of ten. The p-nitrostilbene system was many orders of magnitude more reactive than the stilbene system in both isomerization and exchange reactions. Media rich in dimethyl sulfoxide gave rates of reaction many powers of ten faster than the hydroxylic solvents. (auth)

8287 ELECTROPHILIC SUBSTITUTION AT SATURATED CARBON. XXIX. RELATIONSHIPS BETWEEN POSITION OF PROTONATION OF ALLYLIC ANIONS AND THE KINETIC AND THERMODYNAMIC STABILITIES OF THE OLEFINIC PRODUCTS. Ela, Stephen W.; Cram, Donald J. (Univ. of California, Los Angeles). J. Amer. Chem. Soc., 88: 5777-91(Dec. 20, 1966).

The relationship between the kinetic and thermodynamic stabilities of proton–tautomeric olefins and the position of protonation of their derived allylic anions was examined. The four 1,3-diphenylbutenes were synthesized, characterized, and interconverted in t-butyl alcohol–potassium t-butoxide. At 40°C the equilibrium proportions were 32% trans-1,3-diphenyl-1-butene (I), 52% cis-1,3-diphenyl-2-butene (II), 15% trans-1,3-diphenyl-2-butene (III), and 1% cis-1,3-diphenyl-1-butene (IV). The second-order rate constants (l/mole sec) for isomerization of the olefins at 40°C were as follows: I, 5.1×10^{-5}; II, 3.2×10^{-5}; III, 1.8×10^{-6}; and IV, 7.5×10^{-8}. The ratio of rate constants for isotopic exchange and isomerization (k_e/k_i) was estimated for each olefin in t-butyl alcohol-O-d: I, <0.3, II, 17; III, 21; IV, <0.07. Configurationally discrete isomeric allylic carbanions (A and B) are required to explain the interconversions of I and II on the one hand and of I and III on the other. The energy barrier for direct interconversion of the two allylic anions is estimated to be greater than 3 kcal/mole at 40°C. The large difference in reactivity between IV and the other three olefins is discussed in terms of a third allylic anion less stable than the other two. The stabilities of the allylic anions are correlated with the magnitudes of the 1,3 steric interactions between substituents cis to one another in the plane of the anion. The ratios of k_e/k_i, corrected for intramolecular proton transfer, were used to estimate the "collapse ratios" of the isomeric allylic anions. Protonation of carbanion A to form II was about 35 times faster than protonation to form I. Protonation of carbanion B to form III was about 40 times faster than to form I. These unbalanced "collapse ratios" of carbanions A and B are attributed to the inductive effects of the methyl groups, which direct protonation to the less substituted sites. The relative ground-state stabilities of the olefins appear to have little influence upon the magnitudes of the collapse ratios. (auth)

8288 ELECTROPHILIC SUBSTITUTION AT SATURATED CARBON. XXX. BEHAVIOR OF PHENYLALLYLIC ANIONS AND THEIR CONJUGATE ACIDS. Ela, Stephen W.; Cram, Donald J. (Univ. of California, Los Angeles). J. Amer. Chem. Soc., 88: 5791-5802(Dec. 20, 1966).

Allylbenzene (I) and cis- and trans-propenylbenzene (cis- and trans-II) were each equilibrated at 25°C in dimethyl sulfoxide–potassium t-butoxide to give 97.75% trans-II, 2.20% cis-II, and about 0.05% I. Equilibrium mixtures at 97°C in t-butyl alcohol–potassium t-butoxide contained 93.95% trans-II, 5.73% cis-II, and 0.32% I. The isomerization and exchange reactions of each olefin were studied in potassium t-butoxide–t-butyl alcohol. The second-order rate constant for isomerization of allylbenzene at 25°C was 1.5×10^{-5} l/mole sec, and trans-II was formed 12.9 times faster than cis-II. The trans-allylic anion intermediate underwent proton capture to give trans-II about three times as fast as to give I at 25°C. Isotopic exchange of cis-II in deuterated solvent at 98°C was six to seven times faster than isomerization. Under the same conditions, exchange of trans-II was three to six times faster than isomerization. The balanced collapse ratio of the trans-allylic anion is discussed in terms of the ability of a phenyl group to stabilize both a carbanion and an olefinic double bond. The relative stabilities of cis and trans carbanions are discussed. The rates of loss of allylic protons from 12 methyl- and phenyl-substituted propenes are calculated. (auth)

8289 THE PREPARATION AND PROPERTIES OF trans-CINNAMOYL-PAPAIN. Brubacher, Lewis J.; Bender, Myron L. (Northwestern Univ., Evanston, Ill.). J. Amer. Chem. Soc., 88: 5871-80(Dec. 20, 1966).

trans-Cinnamoyl-papain was prepared from the reaction of excess trans-cinnamoylimidazole with papain at pH 3.43 followed by gel filtration to remove the excess substrate and products. The difference spectrum of trans-cinnamoyl–papain vs. papain was determined by an indirect method since this acyl-enzyme is not stable under the conditions of its preparation. The deacylation of trans-cinnamoyl-papain was first order in acyl-enzyme and was identical with the rate of appearance of trans-cinnamic acid. The rate of the deacylation reaction was dependent on a basic group of $pK_a = 4.69$. In deuterium oxide, the rate was reduced 3.35-fold and the pK_a of the base controlling the reaction was raised 0.34 pK unit. Added nucleophiles including both amines and alcohols increased the rate of disappearance of the acyl-enzyme by competing with water for the acyl-enzyme. The second-order rate constants for the reactions of nucleophiles with the acyl-enzyme were larger for amines than for the corresponding alcohols; furthermore, they were dependent on the structure of the alkyl group of the nucleophile. The basicity of the nucleophile appeared to be of little importance. This last observation together with the D_2O effect suggested that the group of $pK_a = 4.69$ acted as a general basic catalyst in deacylation. (auth)

8290 THERMAL DIFFUSION OF ELECTROLYTES IN ORDINARY AND HEAVY WATER. Becsey, J. G.; Bierlein, James A. (Aerospace Research Labs., Wright-Patterson Air Force Base, Ohio). J. Chem. Phys., 46: 391-2(Jan. 1, 1967).

Experimental results for Soret coefficients and heats of transport of $AgNO_3$, $BaCl_2$, $CdSO_4$, and KI in water and deuterated water are reported. Data agree with those of previous investigators. Heats of transport of the electrolytes were in every case much lower in the heavy water. Viscosities of the solutions deviated only slightly from Walden's rule; however, the ratio $(D_\eta)_{D_2O}/(D_\eta)_{H_2O}$ appears to be significantly smaller than unity for most of the solutions, suggesting that the Stokes–Einstein radii of hydrated ions tends to be somewhat greater in heavy water. (P.C.S.)

8291 KINETICS OF ADSORPTION OF ^{133}Xe FROM AIR MEDIA BY CARBON ADSORBENT. Trofimov, A. M.; Pankov, A. M.; Kovarskii, A. P. Radiokhimiya, 8: 240-5(1966). (In Russian).

The rates of adsorption and desorption of ^{133}Xe from the air by various activated carbons and at various filtration speeds (11.3, 28.7, 45.8, and 58.6 $cm^3/cm^2/min$) were studied. The mass exchange coefficient was determined as a function of the rate of gas-macrocomponent flow. The experiment with one type of carbon (SKT) showed that at the investigated rate the mass exchange coefficient was not affected by the sorbent grain diameter. It was also found that ^{133}Xe had different adsorption and desorption rates. (R.V.J.)

8292 INFRA-RED SPECTRA OF THORIUM NITRATE PENTAHYDRATE AND PRODUCTS OF ITS DEHYDRATION IN A VACUUM. Vdovenko, V. M.; Statsevich, V. P.; Suglobov, D. N. Radiokhimiya, 8: 211-18(1966). (In Russian).

The infrared spectra of thorium nitrate pentahydrate, tetrahydrate, and products of pentahydrate thermal dehydration in a vacuum at 400 to 3800 cm^{-1} were measured. The number and position of NO_3 frequencies in the thorium nitrate spectra indicated the existence of two coordinated nitrate groups with the relative content depending on the water content of the hydrate. The thorium nitrate dissociation products contained bridging nitrate groups and

Grachev, S. A.; Gracheva, L. M.; Petrov, L. N. Radiokhimiya, 8: 376-9(1966). (In Russian).

An attempt was made to demonstrate the stability of primary molecular ions as a function of the conjugation of the initial molecular system and of the degree of conjugation of the isoelectron primary molecular ions. Coplanarity is the principal condition of coupling with aromatic nuclei. The results of previous investigations on molecular spectra and photoionization of various aromatic derivatives of trivalent P, As, Sb, and Bi showed that such systems are conjugated. However, the conjugation is affected by spatial coplanarity difficulties. This factor was considered in studies of changes taking place in ^{210}Bi decay in mesityl derivatives of the trivalent bismuths $[1,3,5\text{-}(CH_3)_3C_6H_2]_3Bi(RaE)$ which in ortho position to each Po–C bond has two methyl groups. The presence of six methyl substitutes near the control atom disrupts the coplanarity of the system and reduces its conjugation and also the yield of products of stabilized primary molecular ions. The results of chromatographic analysis of the spectrum of polonium organic compounds formed in ^{210}Bi β decay in trimesityl bismuth showed that the yield of stabilized primary molecular ions R_3PoX is sharply reduced (~35%) in comparison with the yields of derivatives of other organic compounds. (R.V.J.)

8256 ADSORPTION OF CURIUM ON THE POLISHED PLATINUM SURFACE. Samartseva, A. G. Radiokhimiya, 8: 269-77 (1966). (In Russian).

The adsorption of $^{242}Cm(10^{-12}\underline{M})$ on the surface of platinum in HNO_3 solution was investigated as a function of the hydrogen ion concentration in the range from 10^{-1} to 10^{-12} $\underline{M}$. It was found that up to pH = 3 the sorption was insignificant (1 to 2%), whereas at pH = 3 to 4, the curium adsorption on platinum sharply increased (98 to 100%). The sorption maximum was extended up to pH = 4 to 6, after which the sorption of the radioactive element was decreased by 10%. The sorption of curium on platinum from solutions, first aged for 24 hrs in glassware, was decreased for all pH values by 25 to 30% in comparison with the adsorption from freshly prepared solutions. The adsorption of ^{242}Cm on platinum in the absence of silicic acid from freshly prepared solutions and from solutions first aged continuously in fluoride sheet dishes did not differ. From the data obtained it was concluded that the state of the radioactive element in pure solutions at every pH value remains constant in the time limits indicated. The adsorption of ^{242}Cm on platinum in the presence of foreign ions (La^{3+}, K^+) and H_2O_2 was also studied. Lanthanum decreased the sorption of Cm in range of the maximum by 50 to 60% and K increased the sorption of Cm in the area of high pH values. In the presence of H_2O_2 the sorption of Cm on platinum did not change up to pH = 7. At pH > 8 with increase of the concentration of H_2O_2 up to 0.5 $\underline{M}$ in the solution, the sorption of curium on platinum increased by 100%. On the basis of the data obtained a new quantitative method for the separation of indicator quantities of carrier-free curium on platinum was developed. (tr-auth)

8257 CONDUCTANCE TITRATIONS IN DILUTE OLEUM AND THE DISSOCIATION CONSTANT OF DISULFURIC ACID IN SOLVENT SULFURIC ACID. Mountford, G. A.; Wyatt, P. A. H. (Univ. of Sheffield, Eng.). Trans. Faraday Soc., 62: 3201-16 (Nov. 1966).

Conductance titrations of oleums with potassium hydrogen (or deuterium) sulphate were carried out at 25 and 69° in both the hydrogen and the deuterium sulphuric acid systems. A single experiment was also carried out at 11° with the hydrogen system. The conductance at the minimum in such titrations was greater than that of the pure acid and indicates that the hydrogen (deuterium) disulphate ion has an appreciable mobility, which must be taken into account in the analysis of the results to determine K_a. In the H_2SO_4 system, the K_a of $H_2S_2O_7$ was 0.025 mole (kg solv)$^{-1}$ at 25° and 0.029 at 69°, implying ΔH_a = 0.7 kcal mole^{-1}: the single experiment at 11° gave 0.022, confirming the small temperature dependence. In the D_2SO_4 system, the K_a of $D_2S_2O_7$ was 0.0060 (same units) at 25° and 0.0074 at 69°, implying ΔH_a = 1.0 kcal mole^{-1}. The sensitivity of these numbers to the choice of other constants is examined, and simple rules are given for estimating the effects of any subsequent adjustments in these constants. (auth)

8258 STUDIES OF HYDROGEN HELD BY SOLIDS. PART II. INTERACTION OF SIMPLE OLEFINS AND PYRIDINE WITH DECATIONATED ZEOLITES. Liengme, Bernard V.; Hall, W. Keith (Mellon Inst., Pittsburgh). Trans. Faraday Soc., 62: 3229-43 (Nov. 1966).

Three OH stretching bands, with maxima at about 3745, 3650, and 3545 cm^{-1}, were present in infrared spectra of decationated X- and Y-type zeolites. Pyridine reacted with the 3650 cm^{-1} species to form pyridinium ion. This band underwent a hydrogen bonding shift when ethylene was adsorbed at room temperature, indicating a strong physical adsorption which was quantitatively and rapidly reversible on raising or lowering the pressure. No exchange occurred between C_2H_4 and the OD groups of an exhaustively deuterated zeolite. The hydrogen bonding shift from 3650 to 3300 cm^{-1} was identical when C_2D_4 was substituted for C_2H_4. The 3745 and 3545 cm^{-1} bands were not noticeably altered by the adsorption, at least in the pressure region where the 3650 cm^{-1} band was affected. Adsorption isotherms, calculated from the spectra, could be superimposed on those determined by volumetric techniques. Both were close to Langmuir-type but showed evidence of a superimposed non-selective adsorption at higher pressures. Ethylene may also adsorb, via a charge transfer interaction, on the residual Na^+ ions of the zeolite. At about 500 torr, the total adsorption of C_2H_4 was about 30% greater than the available zeolite hydroxyl groups. It was inferred that the strongest interaction was with the acidic hydroxyl groups and that, at low pressures, most of the adsorbed C_2H_4 was hydrogen-bonded to these. In the CH bending and stretching regions, only the Q-branch of the spectra of the gaseous molecules appeared, indicating that molecular rotation was hindered in the adsorbed state. Qualitatively similar results were obtained with C_3H_6. The hydrogen-bonding shift was greater by about 100 cm^{-1}, however, and the adsorption was not entirely reversible. Moreover, the irreversible portion increased with time, and products stemming from polymerized olefin could be recovered; also, C_3D_6 exchanged with the OH groups of the 3650 and 3545 cm^{-1} bands, but not with those of the 3745 cm^{-1} band. Preliminary results for these substrates adsorbed on dehydroxylated, decationated zeolites are given. (auth)

8259 SODIUM AMALGAM CASE HARDENING OF MICROQUANTITIES OF CARRIER-FREE RARE EARTHS IN ACETATE SOLUTIONS. Novgorodov, A. F.; Khalkin, V. A.; Wang, Chuang-pin. Radiokhimiya, 8: 347-52(1966). (In Russian).

Systematic studies were made on the case hardening process of ultra-small quantities of rare earth elements. The degree of case hardening of carrier-free isotopes from La to Eu and Yb as a function of total concentration of acetate and sodium chloride is tabulated. The case hardening of the light lanthanides and ytterbium was suppressed by the presence of weighable quantities of elements which did not case harden. (tr-auth)

8260 DIFFUSION OF $H_2{}^{18}O$ MOLECULES IN CONCENTRATED AQUEOUS SOLUTIONS OF SOME SALTS. Tamas, Jozsef; Ujszaszy, Kalman (Research Lab. for Chemical Structures, Budapest). Magyar Kem. Foly, 72: 447-53(Oct. 1966). (In Hungarian).

Diffusion coefficients for $H_2{}^{18}O$ were determined in KCl, $CaCl_2$, NaI, CsI, and CsF solutions at room temperature at various concentrations with the aid of the open-end capillary method. The molecules' effect was the sum of the ions' effect present; the effect of viscosity was in correlation with the theory of Podolsky, R. J., (J. Amer. Chem. Soc., 80: 4442(1958)). An equation derived on the basis of the Hartley-Crank flow-medium model (Trans. Faraday Soc., 45: 801(1949)) described accurately the relationship between the isotopic diffusion coefficients of the components and the differential diffusion coefficient of the salt. (JPRS)

8261 INFRARED SPECTRA OF THE WATER CONTAINED IN URANYL NITRATE HYDRATES. Karyakin, A. V.; Nemodruk, A. A.; Petrov, A. V.; Bezrogova, E. V. (Vernadskii Inst. of Geochemistry and Analytical Chemistry, Academy of Sciences, USSR). Dokl. Akad. Nauk SSSR, 168: 817-20(June 1, 1966). (In Russian).

The last two molecules of water in the uranyl nitrate hydrates are retained tenaciously. The dihydrate and trihydrate were prepared from the hexahydrate of uranyl nitrate by drying over 63 and 93% sulfuric acid respectively, and infrared absorption spectra in purified tributyl phosphate (TBP) were taken at 3000 to 4000 cm^{-1}. The differential infrared absorption spectrum of the dihydrate with respect to anhydrous TBP showed two water absorption bands with maxima at 3140 and 3660 cm^{-1}. This behavior indicated that water followed the uranyl ion on extraction with TBP. The difference in synphase and antiphase oscillations in the spectrum indicated unsymmetrical loading of the oxygen atoms. It was concluded from the data that both water molecules in uranyl nitrate dihydrate are each coordinated by means of its own oxygen atom to the uranium atom, and at the same time, by means of one of the hydrogen atoms, the water atoms are coordinated to the oxygen of the uranyl group with the formation of a very strong hydrogen bond of 9.5 kcal/mole. (TTT)

8262 URANIUM MONOSULPHIDE CRYSTALLIZED FROM SULPHURATED URANIUM MELT. Itoh, Hikaru (Mitsubishi Metal Mining Co., Ltd., Omiya, Japan); Akimoto, Yumi; Ishii, Bumpei. J. Nucl. Sci. Technol. (Tokyo), 3: 497-8(Nov. 1966).

The crystallization of US from Mo–U alloys reacted with H_2S in an argon plasma flame is discussed. After extinction of the flame, the sample was allowed to cool. The sample was then sliced, pol-

ished, and etched with nitric acid at ~50°C. X-ray diffractography of the sample showed strong lines of US. The crystals were dendritic or plate-like in shape. Electron-probe analysis indicated that these crystals formed while the matrix was still molten. (M.C.G.)

8263 THE CRYSTAL STRUCTURE OF URANIUM IMIDE CHLORIDE U(NH)Cl. Berthold, H. J.; Knecht, H. (Univ., Mainz). Z. Anorg. Allg. Chem., 348: 50-7(Nov. 1966). (In German).

Uranium imido chloride, U(NH)Cl, obtained by high-temperature ammonolysis of UCl_4 and UCl_3 crystallizes with the PbFCl-layer structure (space group D_{4h}^7-P4/nmm) with two molecules in the tetragonal unit cell. The lattice constants are a = 3.972 ± 0.05 and c = 6.180 ± 0.010 Å. Intensity calculations gave for uranium the parameter U = 0.168 ± 0.001 and for chlorine the parameter V = 0.63 ± 0.005. The much smaller effective radius of the NH^{2-} ions in U(NH)Cl in comparison with the radius in other salt-like imides suggests that the NH^{2-} groups in U(NH)Cl are restricted from free rotation by hydrogen-bond formation. Shortest distances are: $NH^{2-} - NH^{2-}$ = 2.81; $U^{3+} - 4NH^{2-}$ = 2.29; $U^{3+} - 4Cl^-$ = 3.13; $U^{3+} - 1Cl^-$ = 3.15; U − U = 3.62; and Cl − Cl = 3.32 Å. (auth)

8264 AUTOMATIC AND COULOMETRIC TITRATIONS IN STUDIES OF CHEMICAL KINETICS. III. EVALUATION OF THE RATE CONSTANT FOR THE DISPROPORTIONATION OF URANIUM(V) BY AUTOMATIC AMPEROMETRIC TITRATIONS OF URANIUM(VI) WITH CHROMIUM(II). Carr, Peter W.; Meites, Louis (Polytechnic Inst. of Brooklyn). J. Electroanal. Chem., 12: 373-84(Nov.-Dec. 1966).

The rate constants for the disproportionation of uranium(V) in perchlorate solutions having hydrogen-ion concentrations between 0.01 and 1.0M were evaluated by adding a solution of chromium(II) at a constant rate to one of uranium(VI), employing a vibrating dropping mercury electrode to follow the variation of the concentration of either uranium(VI) or uranium(V). The resulting values are in acceptable agreement with those obtained by other techniques. (auth)

8265 STUDY OF THE DISTRIBUTION OF URANIUM AND IRON CATIONS IN THE MIXED OXIDE WITH THE FORMULA $Sr_3UFe_2O_9$. Berthon, Jacques; Ropars, Claude; Bernier, Jean-Claude; Poix, Paul (Univ., Paris, Orsay, France). Compt. Rend., Ser. C, 263: 1304-5(Nov. 21, 1966). (In French).

A crystallographic study of the mixed oxide $Sr_3UFe_2O_{9-\epsilon}$ led to the following distribution: $Sr_6(Fe_4)(Fe_{1\frac{1}{2}}U_{\frac{1}{2}})O_{24-\frac{X}{2}}(O \leq X \leq 0.3)$. The iron and uranium are ordered on the two sites 4a and 4b of the crystalline lattice defined by the space group F m 3 m. (tr-auth)

8266 VARIATION WITH TEMPERATURE OF THE VELOCITY OF U HYDRIDATION. Amilhat-Caralp, Francoise; Casahoursat, Lucien; Destriau, Michel (Univ., Bordeaux). Bull. Soc. Chim. France, No. 11, 3594-8(Nov. 1966). (In French).

The velocity of U hydridation was a maximum at a temperature slightly above 200°C in the case of solid metal and close to room temperature for metal divided by hydridations and dehydridations. The mechanism, a nucleation-type at low temperature and for the massive metal, evolved toward a diffusion mechanism by elevation of the temperature or division of the metal. (tr-auth)

8267 A STUDY OF THE URANYL NITRATE-o-AMINOPHENOL-p-SULFONIC ACID SYSTEM. Mavrodin, Maria (Institut de Chimie Inorganique, Bucharest). Rev. Roum. Chim., 11: 1159-73(Oct. 1966). (In French).

Spectrophotometric, conductometric, and pH studies were made on the reaction between uranyl nitrate and o-aminophenol-p-sulfonic acid(4-hydroxy-metanilic acid). A quantitative study of the system indicated the formation of three complexes, stable at different pH levels, and which corresponded to the ratios of formation: UO_2^{2+} : R = 1 : 1 (pH 2.7); 1 : 2 (pH = 3.5 to 5); 1 : 1 (pH = 7 to 9). The use of o-aminophenol-p-sulfonic acid as a reagent for the spectrophotometric determination of uranium(VI) was also investigated. (tr-auth)

8268 PECULIARITIES OF THE VACUUM-THERMAL METHOD OF PREPARATION AND SOME PROPERTIES OF YTTRIUM AND GADOLINIUM BORIDES. Manelis, R. M.; Meerson, G. A.; Zhuravlev, N. N.; Telyukova, T. M.; Stepanova, A. A.; Gramm, N. V. Porosh. Met., Akad. Nauk Ukr. SSR, No. 11, 77-84(Nov. 1966). (In Russian).

Conditions for obtaining yttrium and gadolinium borides by vacuum-thermal reduction of yttrium and gadolinium oxides by boron was investigated. The conditions for obtaining YB_4, YB_6, YB_{12}, GdB_4, and GdB_6 were worked out. The compounds YB_6, YB_{12}, and GdB_6 were stable in a vacuum up to a temperature of 1700°C. But they dissociated under higher temperatures forming tetraborides and the boron sublimates. A hypothetical state diagram of Gd−B is proposed. Some properties of YB−Gd−B compounds were studied. (auth)

8269 MONOMER-POLYMER EQUILIBRIA OF DEUTERATED α-METHYLSTYRENES. Fetters, Lewis J.; Pummer, Walter J.; Wall, Leo A. (National Bureau of Standards, Washington, D. C.). J. Polym. Sci., Pt. A-1, 4: 3003-11(Dec. 1966).

The equilibria between α-trideuteromethyl-β,β-dideuterostyrene, α-methyl-2,3,4,5,6-pentadeuterostyrene, and perdeutero-α-methylstyrene and their respective polymeric anions in tetrahydrofuran were investigated between 253 and 308°K. The heat and entropy changes were both increased by deuteration of the alkyl group. Qualitatively the effects appear best explained by the premise that a lowering of steric repulsions occurs with deuterium and hence the effective volume for deuterium is less than that for hydrogen. (auth)

8270 PARAMAGNETIC CATALYSIS OF THE ORTHO-PARAHYDROGEN CONVERSION. Nielsen, Svend E.; Dahler, John S. (Univ. of Minnesota, Minneapolis). J. Chem. Phys., 46: 732-44(Jan. 15, 1967).

A theory is presented for the paramagnetic catalysis of ortho-para transitions in molecular hydrogen, deuterium, and tritium. The cause for reaction is taken to be an inhomogeneous magnetic field, originating from a catalyst molecule and operative during the binary collisions of catalyst and reactant species. Formulas for the distorted wave approximation to the cross sections are presented, as are expressions for the specific rates of the associated thermal reactions. Exploratory calculations are performed for the oxygen catalyzed para(L = 0) → ortho(L = 1) transition in hydrogen. With the assumption of a hard-sphere interaction the rates calculated for 77.3 and 86°K are only about 25 to 30% of the experimentally observed rates. (auth)

8271 SURFACE DIFFUSION OF DEUTERIUM AND LIGHT HYDROCARBONS IN MICROPOROUS VYCOR GLASS. Hwang, Sun-Tak; Kammermeyer, Karl (Univ. of Iowa, Iowa City). Sep. Sci., 1: 629-39(1966).

The significance of the surface diffusion of helium through a microporous Vycor glass is emphasized, and the experimental evidence is presented. Permeability data of D_2, CH_4, C_2H_6, and C_3H_8 are reported over a wide temperature range, and the results are analyzed numerically. Comparisons were made for D_2-H_2 and $C_3H_8-CO_2$ systems. Finally, the separation factors for $CO_2-C_3H_8$ and $CH_4-C_3H_8$ systems are discussed. All the experimental work was carried out with porous Vycor glass as the microporous medium. However, there is good reason to believe that the basic findings will hold for any other microporous barrier. Differences will only be a matter of magnitude and will be determined by the adsorption interaction of the respective gas-solid system. (auth)

8272 SERIES SOLUTIONS AND ROTATIONLESS STATES OF THE VIBRATING HYDROGEN MOLECULE ION. Harriss, Donald K. (Univ. of Minnesota, Duluth). J. Chem. Phys., 46: 766-71(Jan. 15, 1967).

The generalized series solution methods for nonseparable Hamiltonians proposed by Frost were investigated. It is shown that for the general case a solution is not possible without explicit evaluation of a minimum number of integrals. The B matrix method is shown to be equivalent to the use of the integral relations, J(f), developed in Hirschfelder's derivation of quantum-mechanical hypervirial theorems. The B matrix method was applied to vibrating H_2^+, HD^+, and D_2^+. (auth)

8273 SPECTRUM OF GASEOUS UCl_4. Morrey, J. R. (Battelle Northwest Labs., Richland, Wash.); Carter, D. G.; Gruber, John B. Contracts AT(45-1)-1830; AT(11-1)-34. J. Chem. Phys., 46: 804-9(Jan. 15, 1967).

The spectra between 4,000 and 23,000 cm^{-1} of gaseous UCl_4 have been obtained for the temperature range 950 to 1250°K. These spectra have been compared with those of single-crystal UCl_4 at 77°K and room temperature. Spectra of solid UCl_4 were obtained over the temperature range 300 to 827°K in order to compare with the gas. In general, the molar absorptivities of the gas are a factor of 10 attenuated over the solid. The energy levels of the gaseous state do not shift appreciably with temperature but, in general, the spectrum of the gas is shifted to the red side of the high-temperature solid spectra. With the exception of a general shift, the spectrum of the vapor is remarkably similar to that of the solid. (auth)

8274 EXCHANGE REACTIONS OF 2.8-eV TRITIUM ATOMS WITH ISOTOPIC MOLECULAR HYDROGEN: H_2, D_2, AND HD. Chou, C. C.; Rowland, F. S. (Univ. of California, Irvine). J. Chem. Phys., 46: 812-13(Jan. 15, 1967).

A series of competitive experiments for exchange of tritium with H_2, D_2, and HD were carried out using 2.8-eV tritium atoms from photolysis of TBr. A much lower isotope effect was observed than in recoil tritium experiments. (M.C.G.)

8275 ON THE EXISTENCE OF A HIGHER VALLENCE OF CURIUM IN SOLUTION. CRITICAL STUDY OF OXIDATION BY OZONE. Pages, Monique; Demichelis, Rene (Institut de Physi-

que Nucleaire, Paris). Compt. Rend., Ser. C, 263: 938-40 (Oct. 17, 1966). (In French).

Experiments were made on the adsorption on anion resin treated with ozone of curium and gadolinium. They show that ozone degrades the anion resin. Therefore, deductions drawn previously on the oxidation of curium to the valence six in solution were shown to be erroneous. (tr-auth)

8276 THERMOGRAVIMETRIC STUDY, DIFFERENTIAL THERMAL ANALYSIS, AND INFRARED ABSORPTION SPECTROGRAPHY OF URANIUM PEROXIDE HYDRATES. Rocchiccioli, Claude (Ecole Nationale Superieure de Chimie, Paris). Compt. Rend., Ser. B, 263: 1061-3(Nov. 7, 1966). (In French).

The infrared absorption spectra of the compounds $UO_4 \cdot 4H_2O$ and $UO_4 \cdot 2H_2O$ were found to be compatible with the peroxide structure. (tr-auth)

8277 INHIBITING ACTION OF SOME SULFUR-CONTAINING MOLECULES ON LIQUID SCINTILLATORS. Serres, P.; Commanay, L.; Guiraud, R.; Teyssier, J. L.; Blanc, D. (Toulouse Univ. Centre de Physique Nucleaire, Toulouse). Int. J. Appl. Radiat. Isotop., 17: 668-70(Dec. 1966). (In French).

The inhibiting action of sulfur, carbon disulfide, thiophene, and thiophenol on the classic liquid scintillator obtained by the dissolution of 2-5-diphenyl oxazole (PPO) and 1-4-di(2-5)-phenyl oxazolylbenzene (POPOP) toluene was studied. The results showed that with all the sulfur compounds the logarithm of the pulse amplitudes decreased linearly with an increase of concentration. However, the degree of inhibition varies significantly with the nature of the sulfur compound. The inhibition is less for thiophene and most for carbon disulfide and thiophenol. A comparison of the inhibiting action calculated by the Storn Volmer equation and that obtained experimentally showed that this equation is insufficient. (J.S.R.)

8278 FLUORESCENT PROPERTIES OF TRIVALENT RARE EARTHS IN FLUORITE STRUCTURE OXIDES. Linares, Robert C. (Perkin-Elmer Corp., Norwalk, Conn.). J. Opt. Soc. Amer., 56: 1700-3(Dec. 1966).

The fluorescent properties of the trivalent rare earths were studied in the fluorite structure oxides, CeO_2 and ThO_2. In these compounds, the cations occupy sites of cubic symmetry, but the symmetry of the trivalent rare earth depends on the concentration and the manner of charge compensation. The emission spectra, fluorescent lifetimes, and excitation spectra were studied as functions of these variables. Multiple-emission spectra of the trivalent ions were observed which varied with concentration and charge compensation. These changes were attributable to multiple sites for the rare earth under the various conditions. The multiple spectra could be well separated in the case of the $^5D_0$–$^7F_1$ transition of Eu^{3+} in ThO_2 which shows at least three distinct spectra. A twofold enhancement of fluorescent lifetime was found to occur when the rare earth was placed in a predominantly cubic environment. The excitation spectra did not change detectably from those expected from known energy levels, but energy transfer was found to occur from the CeO_2 band edge (~38 000 cm^{-1}) to Eu^{3+}, Sm^{3+}, and Er^{3+}. (auth)

8279 PREPARATION OF URANIUM CARBIDE FROM URANIUM CHLORIDE. Mukaibo, Takashi; Kanno, Masayoshi; Mitamura, Takashi; Yoshihara, Kazuhiro (Tokyo Univ.). J. Nucl. Sci. Technol. (Tokyo), 3: 388-92(Sept. 1966).

A method was developed for the preparation of uranium monocarbide using UCl_4 as starting material. The reaction of UCl_4, Al, and graphite powder mixtures under Ar atmosphere was selected for reasons of availability of material and facility of post-reaction processing. It was confirmed by chemical and x ray analyses that UC was obtained at temperatures between 600 and 1,200°C. The purest UC was obtained at 900°C, and the conversion efficiency of uranium reached a maximum of about 80%. (auth)

8280 EXPERIMENTS ON ADSORPTION OF RADIOACTIVE IODINE VAPOR ON SMALL METALLIC FUME PARTICLES. Takahashi, Kanji (Kyoto Univ.). J. Nucl. Sci. Technol. (Tokyo), 3: 401-3(Sept. 1966).

Molecular iodine vapor was generated and mixed with metallic fumes and the adsorption of iodine vapor on fume particles was evaluated by a method using a diffusion tube. The adsorption rate of vapor on aerosol particles was examined by changing the mixing time of vapor with the particles. No detectable difference of adsorption was found when the mixing period ranged from 5 to 240 sec. Iodine vapor adsorption on metallic fumes increased proportionally to vapor concentrations at both low and high vapor concentrations. The adsorbed amounts were much larger than calculated as monolayer adsorption. (D.H.M.)

8281 MILLIMETER-WAVE ROTATIONAL STARK SPECTRA OF HNCO, DNCO, AND HN_3: DIPOLE-MOMENT CHANGES WITH K. White, Kevin J.; Cook, R. L. (Duke Univ., Durham, N. C.). J. Chem. Phys., 46: 143-51(Jan. 1, 1967).

By employing a parallel-plate semifree-space cell the millimeter-wave rotational Stark spectra of HNCO, DNCO, and HN_3 were observed in the ground vibrational state. Analysis of the Stark effect for the $J = 3 \rightarrow 4$ transitions yields the dipole-moment component along the axis of smallest moment of inertia. For these very slightly asymmetric rotors the dipole moment is observed to decrease with increasing K. For HNCO ($J = 3 \rightarrow 4$), the dipole moments are found to be (Debye units) $K = 0$, $\mu_a = 1.613 \pm 0.002$, $K = 1$, $\mu_a = 1.575 \pm 0.002$, $K = 2$, $\mu_a = 1.540 \pm 0.001$, and $K = 3$, $\mu_a = 1.500 \pm 0.002$; for DNCO ($J = 3 \rightarrow 4$), $K = 1$, $\mu_a = 1.602 \pm 0.003$, and $K = 2$, $\mu_a = 1.580 \pm 0.001$; and for HN_3 ($J = 3 \rightarrow 4$), $K = 1$, $\mu_a = 0.8369 \pm 0.0020$, and $K = 2$, $\mu_a = 0.8247 \pm 0.0002$. Results are discussed in terms of the electronic structures of the molecules. (auth)

8282 MICROWAVE SPECTRUM, STRUCTURE, DIPOLE MOMENT, AND BARRIER TO INTERNAL ROTATION OF PHOSPHORUS TRIFLUORIDE-BORANE. Kuczkowski, R. L.; Lide, David R. Jr. (National Bureau of Standards, Washington, D. C.). J. Chem. Phys., 46: 357-65(Jan. 1, 1967).

The microwave spectrum of several isotopic species of phosphorus trifluoride–borane (F_3PBH_3) was measured and the following structural parameters determined: d(BH) = 1.207 ± 0.006 Å; d(PF) = 1.538 ± 0.008 Å; d(PB) = 1.836 ± 0.012 Å; ∠HBH = 115°04′ ± 1°; ∠FPF = 99°50′ ± 1°. The dipole moment was evaluated from Stark splittings as 1.64 ± 0.02 D. The vibrational satellite spectrum associated with the excited $\nu_{12}(E)$ and $\nu_6(A_2)$ states for $F_3P^{11}BH_3$ was strongly perturbed and was fitted to the theory for a first-order Coriolis interaction. The analysis of this perturbation and the measurement of the ν_{12} fundamental in the infrared spectrum permitted the inactive torsional fundamental ν_6 to be determined as 197 ± 5 cm^{-1}. This leads to a potential barrier to internal rotation of 3240 ± 150 cal/mole. The enthalpy of dissociation for the reaction $2\ F_3PBH_3 \rightleftharpoons 2\ PF_3 + B_2H_6$ (298°C) was determined as 10.99 kcal. The experimental results are compared with related compounds. (auth)

8283 THE EMISSION SPECTRUM OF THE PD^+ MOLECULE. Narasimham, N. A.; Dixit, M. N. (Atomic Energy Establishment, Trombay, India). Curr. Sci. (India), 36: 1-3(Jan. 5, 1967).

The spectrum of the PD^+ molecule was obtained in a microwave discharge through phosphorus vapor, deuterium, and helium gas. The bands obtained were similar to the emission bands of PH^+. The new emission bands lay at 3683, 3826, and 4086Å. An analysis of their vibrational and rotational structure showed that they were the 1–0, 0–0, and 0–1 bands of PD^+ involving the $^2\Delta$–$^2\Pi$ transition. (D.H.M.)

8284 RESTRICTED ROTATION IN SOLID DEUTEROMETHANES. Hopkins, Harry P. Jr.; Kasper, Jerome V. V.; Pitzer, Kenneth S. (Rice Univ., Houston, Tex.). J. Chem. Phys., 46: 218-20(Jan. 1, 1967). (ORO–2907-8).

The theory of Nagamiya for restricted rotation in solid methane was extended to all of the partially deuterated species and applied to the experimental heat-capacity data of Colwell, Gill, and Morrison, which showed anomalously high values in the range below 4°K. Agreement with these data was obtained for reasonable values of the energy parameters; also the total entropy of each anomaly was predicted. (auth)

8285 EXCITED-STATE PROTON-TRANSFER REACTIONS. A DEUTERIUM ISOTOPE EFFECT ON FLUORESCENCE. Stryer, Lubert (Stanford Univ., Palo Alto, Calif.). J. Amer. Chem. Soc., 88: 5708-12(Dec. 20, 1966).

A large deuterium isotope effect on fluorescence emission spectra and quantum yields was observed in a number of chromophores that contain proton donor groups. In the absence of a proton donor or acceptor group, there was no appreciable isotope effect. When both the protonated (R^*H) and unprotonated (R^{*-}) excited species were fluorescent, the shape of the emission spectrum was different in H_2O and D_2O. This finding was interpreted in terms of an isotope effect on the rate of proton transfer during the excited-state lifetime in the reaction $R^*H + H_2O \rightleftharpoons R^{*-} + H_3O^+$: k_1 forward, k_2 reverse reaction rates. For 2-naphthol, k_1 is 5.29×10^7 in H_2O and 1.31×10^7 in D_2O; k_2 is 5.5×10^{10} in H_2O and 3.5×10^{10} in D_2O. These rate constants account for the larger proportion of R^{*-} emission seen in H_2O compared to D_2O on excitation of RH. For compounds in which R^{*-} was nonfluorescent, the quantum yield was observed to be higher in D_2O than in H_2O, if a proton donor group was present on the chromophore. It was postulated that this isotope effect on quantum yield was due to a slower rate of proton transfer in D_2O to form a nonfluorescent species during the excited-state lifetime. For example, in 5-amino-1-naphthalenesulfonate, the quantum yield was 3.04-fold higher in D_2O. In contrast, the quan-

tum yield of 1-naphthalenesulfonate was the same in H_2O and D_2O. A comparison of the fluorescence properties of a chromophore in H_2O and D_2O should prove useful in determining whether the excited state is involved in proton-transfer reactions. (auth)

8286 ELECTROPHILIC SUBSTITUTION AT SATURATED CARBON. XXVIII. THE STEREOCHEMICAL CAPABILITIES OF VINYL ANIONS. Hunter, D. H.; Cram, Donald J. (Univ. of California, Los Angeles). J. Amer. Chem. Soc., 88: 5765-76 (Dec. 20, 1966).

The base-catalyzed isomerization and hydrogen isotope vinyl exchange of cis- and trans-stilbene, cis- and trans-α,α'-dideuteriostilbene, and cis- and trans-p-nitrostilbene with solvent were studied. Solutions of potassium t-butoxide in t-butyl alcohol, in t-butyl alcohol–tetrahydrofuran, and in t-butyl alcohol–dimethyl sulfoxide, of potassium hydroxide in dimethyl sulfoxide, of dimsylpotassium in dimethyl sulfoxide, and of potassium methoxide in methanol, and in methanol–dimethyl sulfoxide appropriately deuterated or nondeuterated were employed as media. All isotopic exchanges of both of the cis isomers to give cis isomers occurred through vinyl intermediates. Those cis to trans isomerizations carried out in t-butyl alcohol, t-butyl alcohol–tetrahydrofuran, and in dimethyl sulfoxide probably occurred mainly through vinyl anion intermediates. Those isomerizations observed in methanol or dimethyl sulfoxide–methanol mixtures clearly went by an addition–elimination mechanism. The ratio of rate constants (estimated) of isotopic exchange of cis-stilbene to that of isomerization (k_e^c/k_i^c) changed in a systematic manner from 5×10^3 to 0.8 as a t-butyl alcohol medium was enriched in dimethyl sulfoxide. In dimethyl sulfoxide–dimsylpotassium, the isomerization of cis- to trans-stilbene occurred with about 32% retention of the isotopic label, even though an anionic intermediate was involved. In t-butyl alcohol–potassium t-butoxide, the k_e^c/k_i^c for cis-p-nitrostilbene was about unity. In solvents that contained methanol, the isomerization of this system occurred by an addition–elimination mechanism. In both systems, the cis isomers underwent isotopic exchange faster than the trans isomers by one to two powers of ten. The p-nitrostilbene system was many orders of magnitude more reactive than the stilbene system in both isomerization and exchange reactions. Media rich in dimethyl sulfoxide gave rates of reaction many powers of ten faster than the hydroxylic solvents. (auth)

8287 ELECTROPHILIC SUBSTITUTION AT SATURATED CARBON. XXIX. RELATIONSHIPS BETWEEN POSITION OF PROTONATION OF ALLYLIC ANIONS AND THE KINETIC AND THERMODYNAMIC STABILITIES OF THE OLEFINIC PRODUCTS. Ela, Stephen W.; Cram, Donald J. (Univ. of California, Los Angeles). J. Amer. Chem. Soc., 88: 5777-91(Dec. 20, 1966).

The relationship between the kinetic and thermodynamic stabilities of proton–tautomeric olefins and the position of protonation of their derived allylic anions was examined. The four 1,3-diphenylbutenes were synthesized, characterized, and interconverted in t-butyl alcohol–potassium t-butoxide. At 40°C the equilibrium proportions were 32% trans-1,3-diphenyl-1-butene (I), 52% cis-1,3-diphenyl-2-butene (II), 15% trans-1,3-diphenyl-2-butene (III), and 1% cis-1,3-diphenyl-1-butene (IV). The second-order rate constants (l/mole sec) for isomerization of the olefins at 40°C were as follows: I, 5.1×10^{-5}; II, 3.2×10^{-5}; III, 1.8×10^{-6}; and IV, 7.5×10^{-8}. The ratio of rate constants for isotopic exchange and isomerization (k_e/k_i) was estimated for each olefin in t-butyl alcohol-O-d: I, <0.3, II, 17; III, 21; IV, <0.07. Configurationally discrete isomeric allylic carbanions (A and B) are required to explain the interconversions of I and II on the one hand and of I and III on the other. The energy barrier for direct interconversion of the two allylic anions is estimated to be greater than 3 kcal/mole at 40°C. The large difference in reactivity between IV and the other three olefins is discussed in terms of a third allylic anion less stable than the other two. The stabilities of the allylic anions are correlated with the magnitudes of the 1,3 steric interactions between substituents cis to one another in the plane of the anion. The ratios of k_e/k_i, corrected for intramolecular proton transfer, were used to estimate the "collapse ratios" of the isomeric allylic anions. Protonation of carbanion A to form II was about 35 times faster than protonation to form I. Protonation of carbanion B to form III was about 40 times faster than to form I. These unbalanced "collapse ratios" of carbanions A and B are attributed to the inductive effects of the methyl groups, which direct protonation to the less substituted sites. The relative ground-state stabilities of the olefins appear to have little influence upon the magnitudes of the collapse ratios. (auth)

8288 ELECTROPHILIC SUBSTITUTION AT SATURATED CARBON. XXX. BEHAVIOR OF PHENYLALLYLIC ANIONS AND THEIR CONJUGATE ACIDS. Ela, Stephen W.; Cram, Donald J. (Univ. of California, Los Angeles). J. Amer. Chem. Soc., 88: 5791-5802(Dec. 20, 1966).

Allylbenzene (I) and cis- and trans-propenylbenzene (cis- and trans-II) were each equilibrated at 25°C in dimethyl sulfoxide–potassium t-butoxide to give 97.75% trans-II, 2.20% cis-II, and about 0.05% I. Equilibrium mixtures at 97°C in t-butyl alcohol–potassium t-butoxide contained 93.95% trans-II, 5.73% cis-II, and 0.32% I. The isomerization and exchange reactions of each olefin were studied in potassium t-butoxide–t-butyl alcohol. The second-order rate constant for isomerization of allylbenzene at 25°C was 1.5×10^{-5} l/mole sec, and trans-II was formed 12.9 times faster than cis-II. The trans-allylic anion intermediate underwent proton capture to give trans-II about three times as fast as to give I at 25°C. Isotopic exchange of cis-II in deuterated solvent at 98°C was six to seven times faster than isomerization. Under the same conditions, exchange of trans-II was three to six times faster than isomerization. The balanced collapse ratio of the trans-allylic anion is discussed in terms of the ability of a phenyl group to stabilize both a carbanion and an olefinic double bond. The relative stabilities of cis and trans carbanions are discussed. The rates of loss of allylic protons from 12 methyl- and phenyl-substituted propenes are calculated. (auth)

8289 THE PREPARATION AND PROPERTIES OF trans-CINNAMOYL-PAPAIN. Brubacher, Lewis J.; Bender, Myron L. (Northwestern Univ., Evanston, Ill.). J. Amer. Chem. Soc., 88: 5871-80(Dec. 20, 1966).

trans-Cinnamoyl-papain was prepared from the reaction of excess trans-cinnamoylimidazole with papain at pH 3.43 followed by gel filtration to remove the excess substrate and products. The difference spectrum of trans-cinnamoyl–papain vs. papain was determined by an indirect method since this acyl-enzyme is not stable under the conditions of its preparation. The deacylation of trans-cinnamoyl-papain was first order in acyl-enzyme and was identical with the rate of appearance of trans-cinnamic acid. The rate of the deacylation reaction was dependent on a basic group of $pK_a = 4.69$. In deuterium oxide, the rate was reduced 3.35-fold and the pK_a of the base controlling the reaction was raised 0.34 pK unit. Added nucleophiles including both amines and alcohols increased the rate of disappearance of the acyl-enzyme by competing with water for the acyl-enzyme. The second-order rate constants for the reactions of nucleophiles with the acyl-enzyme were larger for amines than for the corresponding alcohols; furthermore, they were dependent on the structure of the alkyl group of the nucleophile. The basicity of the nucleophile appeared to be of little importance. This last observation together with the D_2O effect suggested that the group of $pK_a = 4.69$ acted as a general basic catalyst in deacylation. (auth)

8290 THERMAL DIFFUSION OF ELECTROLYTES IN ORDINARY AND HEAVY WATER. Becsey, J. G.; Bierlein, James A. (Aerospace Research Labs., Wright-Patterson Air Force Base, Ohio). J. Chem. Phys., 46: 391-2(Jan. 1, 1967).

Experimental results for Soret coefficients and heats of transport of $AgNO_3$, $BaCl_2$, $CdSO_4$, and KI in water and deuterated water are reported. Data agree with those of previous investigators. Heats of transport of the electrolytes were in every case much lower in the heavy water. Viscosities of the solutions deviated only slightly from Walden's rule; however, the ratio $(D_\eta)_{D_2O}/(D_\eta)_{H_2O}$ appears to be significantly smaller than unity for most of the solutions, suggesting that the Stokes–Einstein radii of hydrated ions tends to be somewhat greater in heavy water. (P.C.S.)

8291 KINETICS OF ADSORPTION OF ^{133}Xe FROM AIR MEDIA BY CARBON ADSORBENT. Trofimov, A. M.; Pankov, A. M.; Kovarskii, A. P. Radiokhimiya, 8: 240-5(1966). (In Russian).

The rates of adsorption and desorption of ^{133}Xe from the air by various activated carbons and at various filtration speeds (11.3, 28.7, 45.8, and 58.6 $cm^3/cm^2/min$) were studied. The mass exchange coefficient was determined as a function of the rate of gas-macrocomponent flow. The experiment with one type of carbon (SKT) showed that at the investigated rate the mass exchange coefficient was not affected by the sorbent grain diameter. It was also found that ^{133}Xe had different adsorption and desorption rates. (R.V.J.)

8292 INFRA-RED SPECTRA OF THORIUM NITRATE PENTAHYDRATE AND PRODUCTS OF ITS DEHYDRATION IN A VACUUM. Vdovenko, V. M.; Statsevich, V. P.; Suglobov, D. N. Radiokhimiya, 8: 211-18(1966). (In Russian).

The infrared spectra of thorium nitrate pentahydrate, tetrahydrate, and products of pentahydrate thermal dehydration in a vacuum at 400 to 3800 cm^{-1} were measured. The number and position of NO_3 frequencies in the thorium nitrate spectra indicated the existence of two coordinated nitrate groups with the relative content depending on the water content of the hydrate. The thorium nitrate dissociation products contained bridging nitrate groups and

structural elements inherent in the thorium oxide (Th–O–Th) bonds. Two basic types of water molecules which participate in strong and weak (and simultaneously symmetric) hydrogen bonds are present in the pentahydrate lattice. In lower hydrates equivalent water molecules form comparatively weak hydrogen bonds with the nitrate groups. (R.V.J.)

8293 ISOTOPIC EXCHANGE AS A CRITERION OF THE STRUCTURE OF OCTAHEDRAL $[Me(CNS)_6]^{n-}$ COMPLEXES. II. ISOTOPIC EXCHANGE IN THE SYSTEM $[Mo(NCS)_6]^{3-}-{}^{14}NCS^-$. Wajda, Stanislaw; Pruchnik, Florian (Univ., Wroclaw). Nukleonika, 11: 555-66(1966). (In Polish).

The exchange kinetics of radiocarbon in hexathiocyanatomolybdate (III) was examined. The exchange was found to proceed according to the dissociation mechanism S_{N1} after a certain induction period. On the basis of these data the mechanism of isotopic exchange is given. The magnitude of the activation energy (21.9 kcal/mole) suggests that the Mo–N bonding is covalent but it is weaker than that in the chromium complex. (auth)

8294 EVALUATION OF THE FORCE CONSTANTS OF SOME TETRAHEDRAL MOLECULES. Sahini, V. E.; Fulea, A. O. (Univ. of Bucharest). Rev. Roum. Chim., 11: 1045-50(Sept. 1966).

Five force constants were evaluated from Raman effect data for the molecules: $^{12}CF_4$ and $^{13}CF_4$ and respectively $^{10}BF_4^-$ and $^{11}BF_4^-$, belonging to the T_d symmetry, in the harmonic approximation, applying Wilson's FG matrix method. The values of the force constants were compared with those determined previously by others. (auth)

8295 REVERSIBLE AND IRREVERSIBLE PROCESSES ON THE DROPPING MERCURY ELECTRODE. XX. THORIUM(IV). Sancho, J.; Almagro, J.; Pujante, A.; Rodriguez, A. (Univ., Murcia, Spain). An. Real Soc. Espan. Fis. Quim. (Madrid), Ser. B, 62: 1087-94(Nov. 1966). (In Spanish).

A study of the polarographic behavior of thorium(IV) in water and water–ethanol mixtures of varying compositions has been carried out. Lithium chloride was used as supporting electrolyte while a 2.92 to 3.80 pH range was covered throughout. Constant diffusion current values were observed with a 3.10^{-3}M Th^{4+} solution in 75% ethanol within a 3.03 to 3.60 pH range. Reduction of this element is a diffusion dependent process with an irreversible character; a shift towards reversibility can be observed as ethanol concentration is increased. Different sets of values for the temperature and pressure of the mercury column have been studied for a 1.10^{-3} to 5.10^{-3}M concentration range. A microcoulometric study as well as peak potentials furnished by derivative polarography are included. (auth)

8296 CALCULATION OF COMPLEXITY CONSTANTS FOR THE COMPOUNDS OF MA AND MA_2 TYPES IN THE UO_2–$RCOO^-$ SYSTEMS IN AQUEOUS SOLUTION. Spacu, P.; Popea, Florica; Lepadatu, C. I. (Inst. of Inorganic Chemistry, Bucharest). Rev. Roum. Chim., 11: 1069-72(Sept. 1966).

The complexity constants of some uranyl ion compounds with haloacetic acids $RCOO^-$ (R = CH_2Cl, CH_2Br, $CHCl_2$) of the types MA and MA_2 were estimated by making use of a spectrophotometric method. The results obtained were compared with those for UO_2–CH_3COO^- system and interpreted on the basis of the inductive effect of the ligands. (auth)

8297 CONVERSION AND EQUILIBRATION RATES OF HYDROGEN ON NICKEL. Eley, D. D.; Norton, P. R. (Nottingham Univ., Eng.). Discuss. Faraday Soc., No. 41, 135-48(1966).

The conversion rate of para hydrogen (pH_2) was compared with that for ortho deuterium (oD_2) and $H_2 + D_2 \rightarrow 2HD$ on nickel wires rigorously cleaned in vacuo of 10^{-10} torr. The rates were significantly higher than on evaporated films, prepared under similar conditions but still possibly contaminated. The results at 1 torr fell into three temperature ranges (a) 330 to 400°K, a fractional order (ca. 0.6) reaction, activation energy 5–7.5 kcal $mole^{-1}$ There was evidence for a zero order $H_2 + D_2$ reaction setting in as the pressure was lowered to 0.3 torr; (b) 200 to 300°K, a fractional order reaction, 0.05–0.40, with a lower activation energy, 1.5–2.7 kcal $mole^{-1}$. In (a) and (b), pH_2, oD_2, and $H_2 + D_2$ rates were very similar to each other. On decreasing the temperature to (c) 77–200°K, the activation energies for the pH_2 and oD_2 rates decreased to zero, so that at 77°K these two reactions were 10^3 times faster than $H_2 + D_2$. The mechanisms advanced are for (a) Bonhoeffer–Farkas, (b) Eley–Rideal, and (c) a paramagnetic conversion induced probably by unpaired d electrons in the Ni and proceeding through a Harrison–MacDowell mechanism. (auth)

8298 FORMS OF OXYGEN BONDS ON THE SURFACE OF OXIDATION CATALYSTS. Boreskov, G. K. (Inst. of Catalysis, Academy of Sciences, Novosibirsk, USSR). Discuss. Faraday Soc., No. 41, 263-76(1966).

A study of the isotopic exchange of oxygen on oxides and metals was made in order to gain additional information about the form of the oxygen bond at the surface of catalysts. As a result of high temperature treatment of oxides, there appeared on the surface a form possessing the catalytic activity for isotopic exchange of oxygen at very low temperatures. The exchange of oxygen seemed to proceed through an intermediate formation of many-atom, strictly oriented, complexes. For oxides and metals having an equilibrium content of oxygen in the surface layer, the activity in a homomolecular exchange may serve as a measure of the reactivity of the surface oxygen and is well correlated with the catalytic activity in a series of oxidation reactions. (auth)

8299 ISOTOPIC EXCHANGE BETWEEN DEUTERIUM AND CYCLOALKANE ON PALLADIUM CATALYSTS. Burwell, Robert L., Jr.; Schrage, Klaus (Northwestern Univ., Evanston, Ill.). Discuss. Faraday Soc., No. 41, 215-22(1966).

Results of isotopic exchange between deuterium and the hydrocarbons, bicyclo[3.3.1]nonane, cis- and trans-1,2-dimethylcyclopentane, on palladium–alumina catalysts at about 50°C are reported. An intermediate common to the exchange of both dimethylcyclopentanes gives nearly completely exchanged cis- and trans-1,2-dimethylcyclopentane in the ratio of one to about four. In addition to this two-set exchange process, there is a one-set exchange process unaccompanied by epimerization in which nearly all of the hydrogen atoms in one set exchange. Other processes lead to the exchange of a smaller number of hydrogen atoms. The isotopic distribution patterns of exchanged bicyclononane are inconsistent with the occurrence of one-set exchange via alternation between monoadsorbed alkane and π-complexed olefin but support instead alternation between mono-adsorbed and di-absorbed alkane. The mechanism of two-set exchange is considered in the light of these experiments. Several forms of the π-allyl mechanism and of the roll-over mechanism are consistent with observations. (auth)

8300 REDUCTION AND VOLATILIZATION OF THE RARE EARTH OXIDES. Achard, J.-C. (CNRS, France). Rev. Int. Hautes Temp. Refract., 3: 281-9(July-Sept. 1966). (In French).

The behavior of the pure oxides of La, Ce, Pr, Nd, Gd, Dy, Lu, Er, Sm, and Y in the presence of C under vacuum was studied at different temperatures. The reaction pattern was followed by thermobalance. In order to determine the loss of rare earths from the sample the residue remaining in the ampoule was calcined in air. The quantity of rare earth volatilized at the end of the cycle, the temperature at which the weight loss became apparent, the shape of the curve giving the weight loss as a function of time, and the speed of the reduction reaction were determined and the results are shown graphically and tabulated. Separations were made of the rare earths by the reduction of their oxides. Pure oxides of Lu, Yb, and Eu were prepared. Mixtures of Yb–Tm–Er and Lu–Yb–Tm–Er were separated by oxide reduction. (J.S.R.)

8301 NOBLE GASES. Asimov, Isaac. New York, Basic Books, Inc., 1966. 178p. $4.50.

A study of the noble gases is presented that includes the history of the six gases, their composition and sources, events that led to the knowledge that noble gases could form compounds, and description of their application in modern science and industry. (D.H.M.)

8302 ISOTOPE EFFECTS IN THE IONIZATION OF GASES ON IMPACT OF METASTABLE ATOMS. Penton, James Robert. Gainesville, Fla., Univ. of Florida, 1965. 63p.

Thesis.

A high-resolution mass spectrometer was used to investigate inelastic collisions of metastable helium atoms in H_2, HD, D_2, Ar, Ne, and N_2. The metastable atoms were produced in an electron bombardment source and collimated into a beam. The beam was allowed to traverse a gas-filled collision chamber. Ions formed in the collision chamber were extracted and analyzed in the mass spectrometer. Pressures in the collision chamber were determined from measurements of the appropriate symmetric charge transfer for H_2, HD, and D_2; and from the known cross sections for this process. An isotope effect is noted in the ionization of H_2, HD, and D_2 with the D_2^+ cross section 1.26 times that of H_2^+ and the HD^+ cross section 1.18 times that for H_2. The ions are observed to have appreciable kinetic energy. A mechanism is proposed to explain the isotope effect and the appearance of kinetic energy in the product ions. Further investigations were conducted with metastable helium in methane and methane-d_4. (Dissertation Abstr.)

8303 PHYSICO-CHIMIE DU PROTACTINIUM. COLLOQUES INTERNATIONAUX, ORSAY, 2–8, Juillet 1965. (Physical Chemistry of Protactinium. International Conference, Orsay, July 2–8, 1965). Paris, Centre National de la Recherche Scientifique, 1966. 351p. 56F. (CONF-650728–).

Separate abstracts were prepared for the thirty-eight papers presented. (D.H.M.)

For abstracts of individual papers see: 8304–8323, 8391, 8392 8416–8425, 8483, 9094, 9167, 9240, 10058, and 10059.

8304 COMPLEX HALIDES OF PROTACTINIUM(V). Brown, D. (Atomic Energy Research Establishment, Harwell, Eng.). pp 147-53 of Physico-Chimie du Protactinium. Paris, Centre National de la Recherche Scientifique, 1966.

The preparation and properties of some fluoroprotactinates (V), $M^{I}PaF_6$, $M^{I}_2PaF_7$, and $M^{I}_3PaF_8$ (M^{I} = Li, Na, K, Rb and Cs), chloroprotactinates (V), $M^{I}PaCl_6$ and $M^{I}_3PaCl_8$ (M^{I} = Cs, NMe_4 and Ph_4As), and hexabromoprotactinates (V), $M^{I}PaBr_6$ (M^{I} = NMe_4 and NEt_4), are described. Analogous hexachloro- and hexabromoniobates (V) and tantalates (V) and chlorouranates (V) were prepared. The preparation of stable phosphine oxide complexes of the pentachlorides, MCl_5R_3PO (M = Pa, U, Nb and Ta; R = C_6H_5, C_8H_{17} and NMe_2) is reported. In addition the preparation of the oxyhalides, $PaOBr_3$, PaO_2Br, Pa_2OCl_3 and $Pa_2O_3Cl_4$ is reported. (auth)

8305 PREPARATION AND ANALYSIS OF PROTACTINIUM PENTACHLORIDE. Flegenheimer, J. (Comision Nacional de la Energia Atomica, Buenos Aires). pp 135-45 of Physico-Chimie du Protactinium. Paris, Centre National de la Recherche Scientifique, 1966.

Milligram amounts of protactinium pentachloride were prepared by passing chlorine saturated with carbon tetrachloride over the heated pentoxide at 300 to 400°C. The product was white when present as a fine powder. On slow vacuum sublimation at about 200°C, large, pale yellow-greenish crystals were obtained. Two samples of the chloride were analyzed. Protactinium was weighed as the pentoxide and chlorine titrated by potentiometric method. The analyses agreed with the composition $PaCl_5$. During one of the analyses, use was made of the fact that protactinium pentachloride is extremely soluble in methyl alcohol. Under polarized light, strong dichroism was shown by protactinium pentachloride crystals. (auth)

8306 PREPARATION AND PROPERTIES OF SOME ALKALI FLUORIDE COMPLEXES OF PENTAVALENT PROTACTINIUM. Asprey, L. B.; Penneman, R. A.; Kruse, F. H. (Los Alamos Scientific Lab., N. Mex.). pp 113-18 of Physico-Chimie du Protactinium. Paris, Centre National de la Recherche Scientifique, 1966.

Complex fluorides containing pentavalent protactinium and alkali fluoride were prepared, both from aqueous hydrofluoric acid solution and by fluorine oxidation of intimately ground mixtures containing PaF_4 and alkali fluoride. The major part of the work was done on the rubidium–Pa(V)–fluoride system. X-ray data are reported. Correlation of the properties of the complex fluorides of pentavalent protactinium with those of pentavalent uranium is made. (auth)

8307 BEHAVIOR OF PROTACTINIUM AT HIGH TEMPERATURE. Lapitskii, A. V.; Berdonosov, S. S. (Moscow State Univ.). pp 157-61 of Physico-Chimie du Protactinium. Paris, Centre National de la Recherche Scientifique, 1966. (In French).

A chlorination and bromination study of ^{233}Pa with different carriers was made. The beginning of halogenation of protactinium was at a higher temperature (above 1000°C) than that of the halogenation of the oxide carriers. It was possible to separate carrier-free ^{233}Pa by sublimation of the halogenation products. The behavior of protactinium at high temperatures is discussed. (auth)

8308 OXYACID AND OTHER COMPOUNDS OF PROTACTINIUM(V). Bagnall, K. W. (Atomic Energy Research Establishment, Harwell, Eng.). pp 87-92 of Physico-Chimie du Protactinium. Paris, Centre National de la Recherche Scientifique, 1966.

The program of research on the chemistry of protactinium at Harwell is aimed at correlating its chemistry both with that of niobium and tantalum and, as far as possible, with that of the neighboring actinide elements, thorium, uranium, and neptunium. Some of the problems being investigated at present are described and some recent work on the sulfato- and selenato-complexes of protactirium (V) is discussed. (auth)

8309 QUINQUEVALENT PROTACTINIUM, NIOBIUM, AND TANTALUM NITRATO-COMPLEXES. Jones, P. J. (Atomic Energy Research Establishment, Harwell, Eng.). pp 93-8 of Physico-Chimie du Protactinium. Paris, Centre National de la Recherche Scientifique, 1966.

Dinitrogen pentoxide reacted with protactinium (V) hydroxide, the pentachloride and the chlorocomplex $SO(PaCl_6)_2$, to give a hexanitrato-complex, $HPa(NO_3)_6$, but did not react with protactinium pentoxide. The reaction of hexachloroprotactinates (V) with dinitrogen pentoxide yielded hexanitratoprotactinates (V) $M^{I}Pa(NO_3)_6$ [M^{I} = Cs, NMe_4 and NEt_4], in contrast to the hexachloroniobates (V) and tantalates (V),which reacted to give oxytetranitrato-complexes $M^{I}M^{V}O(NO_3)_4$. Tetramethylammonium hexachloroniobate (V) and tantalate (V) reacted with dinitrogen tetroxide in methyl cyanide to give $NMe_4NbO(NO_3)_4$ and $NMe_4TaOCl_3NO_3$ respectively. (auth)

8310 PROTACTINIUM FLUORIDES. Stein, Lawrence (Argonne National Lab., Ill.). pp 101-7 of Physico-Chimie du Protactinium. Paris, Centre National de la Recherche Scientifique, 1966.

A protactinium fluoride of composition Pa_4F_{17}, analogous to U_4F_{17}, was prepared by reaction of protactinium pentoxide with hydrogen fluoride and hydrogen at 500°C. The compound is black, crystallizing in a bcc lattice (a_0 = 8.507Å, Z = 2). Both uranium (IV) and protactinium(IV) were found to yield complex fluoride sulfates as precipitates in aqueous reactions. Two salts were tentatively identified as $UF_2SO_4 \cdot 2H_2O$ and $PaF_2SO_4 \cdot 2H_2O$. The salts are soluble in water and dilute acids and may be converted to simple tetrafluoride hydrates by washing with hydrofluoric acid. Methods of preparation of several fluorides are described, and infrared spectra of PaF_4, Pa_4F_{17}, $PaF_5 \cdot 2H_2O$, Pa_2OF_8, and $PaF_2SO_4 \cdot 2H_2O$ are reported. The purification of gram amounts of ^{231}Pa by an anion exchange method is described. (auth)

8311 FLUORIDE COMPLEXES OF TETRAVALENT PROTACTINIUM. Asprey, L. B.; Penneman, R. A. (Los Alamos Scientific Lab., N. Mex.). pp 109-12 of Physico-Chimie du Protactinium. Paris, Centre National de la Recherche Scientifique, 1966.

The compound $(NH_4)_4PaF_8$ was prepared from NH_4F and PaF_4. It is isostructural with $(NH_4)UF_8$, $(NH_4)_4NpF_8$, $(NH_4)_4PuF_8$, and $(NH_4)_4AmF_8$. Details of the synthesis of this and other alkali fluoride complexes are given along with structural data. (auth)

8312 COMPLEX FORMATION BETWEEN PROTACTINIUM AND ACETYLACETONE. Liljenzin, J. O.; Rydberg, J. (Chalmers Univ. of Tech., Goteborg). pp 255-72 of Physico-Chimie du Protactinium. Paris, Centre National de la Recherche Scientifique, 1966.

The adsorption of Pa(V) was investigated under various conditions. Using a solvent extraction technique the complex formation between Pa(V) and acetylacetone (HA) was investigated. The species formed were assumed to be PaO_2A, $PaO_2A \cdot HA$ (or $HPaO_2A_2$), and PaO_2OH. Stability constants for these complexes were calculated. Pa(V) was reduced to Pa(IV) on a Pt-hydrogen electrode in aqueous solutions of acetylacetone at pH > 7. Pa(IV) formed complexes with acetylacetone, which were more readily extracted to organic solvents than the Pa(V) complexes. (auth)

8313 THE CHEMISTRY OF PROTACTINIUM: THE FLUORO-COMPLEXES. Bukhsh, M. N.; Flegenheimer, J.; Hall, F. M.; Maddock, A. G.; Ferreira de Miranda, C. (Chemical Lab., Cambridge, Eng.). pp 195-207 of Physico-Chimie du Protactinium. Paris, Centre National de la Recherche Scientifique, 1966.

Ion exchange and conductimetric titration experiments suggest the existence of the PaF_8^{3-} anion. Pure samples of K_2PaF_7 and Na_3PaF_8 were prepared and analyzed. The salt $KPaF_6$ was prepared but a completely pure product could not be obtained from solution. Some observations were made on the ir and NMR spectra of the three complexes. Using an electrochemical method a preliminary set of values for the successive complexing constants k_{1-6} for the protactinium fluoro-complexes was obtained. (auth)

8314 SOLID-STATE CHEMISTRY OF PROTACTINIUM OXIDES. Keller, Cornelius (Technische Hochschule, Karlsruhe, Ger. Karlsruhe Nuclear Research Center, Ger.). pp 73-9 of Physico-Chimie du Protactinium. Paris, Centre National de la Recherche Scientifique, 1966.

The solid-state reactions of protactinium dioxide and protactinium pentoxide with the oxides of some elements of the first to the fourth main group as well as the third to the fifth auxiliary group of the periodic system of elements were investigated. The investigation showed the structural types of the compounds obtained to be characteristic in part of the pentavalent actinides as well as of the elements niobium and tantalum. Reaction conditions and lattice constants of the individual ternary oxides are discussed. (auth)

8315 STRUCTURAL STUDIES ON DOUBLE OXIDES OF PROTACTINIUM. Iyer, P. N.; Smith, A. J. (Univ. of Sheffield, Eng.). pp 81-5 of Physico-Chimie du Protactinium. Paris, Centre National de la Recherche Scientifique, 1966.

The compounds $LiPaO_3$, $NaPaO_3$, and $KPaO_3$ were prepared by solid-state reactions. The sodium compound showed a distorted perovskite structure, but the others were not isostructural with it

or with each other. Solid solutions were observed in the lithium and sodium systems. Oxides of the alkaline earth metals did not react with Pa_2O_5 at the temperatures used. (auth)

8316 X-RAY SPECTROSCOPY OF PROTACTINIUM. Cauchois, Y.; Bonnelle, C. (Laboratoire de Chimie-Physique, Paris). pp 21-6 of Physico-Chimie du Protactinium. Paris, Centre National de la Recherche Scientifique, 1966. (In French).

X-ray spectroscopy makes it possible to determine the energy levels of an element in a given physicochemical state. Following a brief outline of the experimental method, the conditions for obtaining the M absorption spectra (which lies in the 3 Å region) are given, together with the results of absorption measurements with screens of Pa_2O_5. The results are discussed in relation with experimental data obtained in other spectral regions and with neighboring elements. (auth)

8317 CRYSTAL STRUCTURE OF K_2PaF_7. Smith, A. J. (Univ. of Sheffield, Eng.); Brown, D. pp 155 of Physico-Chimie du Protactinium. Paris, Centre National de la Recherche Scientifique, 1966.

The lattice of K_2PaF_7 is C-centered monoclinic with a = 13.94, b = 6.76, c = 8.24 Å, and β = 125.5°, space group C2/c or Cc. The crystals are elongated along [001]. Intensities were collected on Weissenberg films taken about this axis, corrected for absorption, Lorentz, and polarization effects, and three-dimensional Patterson syntheses made. These yielded the Pa and K positions unambiguously and gave a number of possible fluorine positions. (auth)

8318 FLUORINE-CONTAINING COMPLEXES OF PENTAVALENT PROTACTINIUM. DIFFUSE REFLECTANCE SPECTRA. Ferreira de Miranda, C. (Institut du Radium, Arcueil, France). pp 127-34 of Physico-Chimie du Protactinium. Paris, Centre National de la Recherche Scientifique, 1966. (In French).

The diffuse reflectance (D.R.) spectra of K_2PaF_7 and of Na_3PaF_8 was studied. PaF_7^{2-} showed an absorption band at 200 mμ, but PaF_8^{3-} did not absorb between 195 and 500 mμ. K_2PaF_7 decomposed on heating at 130°C and probably gave $KPaF_6$; the reaction was reversed at room temperature. Solid K_2PaF_7 reacted with solid NaF and gave octafluoroprotactinate. It seems likely that K_2PaF_7 formed a labile addition compound with acetone. Adaptation of the D.R. measurements technique to small amounts of radioactive materials is described. (auth)

8319 RAMAN AND ABSORPTION SPECTRA OF PROTACTINIUM FLUORO COMPLEXES. Keller, O. L. Jr.; Chetham-Strode, A. Jr. (Oak Ridge National Lab., Tenn.). pp 119-25 of Physico-Chimie du Protactinium. Paris, Centre National de la Recherche Scientifique, 1966.

The Raman spectra of known complex ions in crystals can be compared with those of unknown complex ions in solutions to allow their identification. An example of the method is the identification of the TaF_6^- and TaF_7^{2-} ions in HF solutions. To apply the method to Pa(V) in HF solutions, $RbPaF_6$ and Rb_2PaF_7 were prepared and analyzed for Rb and Pa. The Raman spectra of these crystals had strong, sharp lines at 590 and 545 cm^{-1}, respectively. The Raman spectra of Pa(V) in several HF solutions was presented. A cell is described that is suitable for obtaining Raman spectra on small volumes of HF solutions. A modification is described for a Phillips x-ray powder camera that makes it safer to obtain diffraction patterns on radioactive samples. (auth)

8320 IONIC SPECIES OF PROTACTINIUM IN DIFFERENT AQUEOUS MEDIA. Guillaumont, Robert (Institut du Radium, Arcueil, France). pp 165-79 of Physico-Chimie du Protactinium. Paris, Centre National de la Recherche Scientifique, 1966. (In French).

The distribution of penta and tetravalent protactinium between various aqueous solutions containing complexing anions and benzene solutions of thenoyltrifluoroacetone was studied. The distribution coefficient was measured as a function of the concentration of chelating agent in the organic phase, as a function of the acidity and concentration of complexing anions in the aqueous phase, and as a function of protactinium. At tracer levels, Pa^V was present as two ionic species in equilibrium $Pa(OH)_3^{2+}$ (or $PaO(OH)^{2+}$) and $Pa(OH)_4^+$ (or $PaO(OH)^{2+}$ or PaO_2^+) in the medium $[H^+] = xN$ $[Li^+] = (3-x)N$ $[ClO_4^-] = 3N$. In 3N $HClO_4$ solution, the monomeric ion corresponding to the tetravalent state was Pa^{4+}. When $[H^+]$ decreased the species $Pa(OH)_n^{(4-n)+}$ with n = 1, 2 and 3 appeared successively. When the protactinium concentration increased $Pa(OH)_3^{3+}$ was not polymerized in contrast to $Pa(OH)_4^+$. In 3N $HClO_4$ medium tetravalent protactinium was present as dimer or trimer species when Pa concentration reaches 10^{-5} M. The hydrolysis constants of the cations $Pa(OH)_3^{3+}$ and Pa^{4+} were calculated as well as the partial constant polymerization of the $Pa(OH)_4^+$ ion. The formulas and the formation constants of the first complexes of Pa^V and Pa^{IV}, which appear in solution of carrier-free ^{233}Pa at ionic strength 3 in presence of Cl^-, SO_4^{2-}, $C_2O_4^{2-}$ and F^-, were determined. (auth)

8321 ADSORPTION OF PENTAVALENT PROTACTINIUM ON SILICA GEL FROM ACID SOLUTIONS. Davydov, A. V.; Marov, I. N.; Palei, P. N. (Inst. of Geochemistry and Analytical Chemistry, Moscow). pp 181-8 of Physico-Chimie du Protactinium. Paris, Centre National de la Recherche Scientifique, 1966. (In French).

The adsorption of ^{231}Pa and ^{233}Pa by silica gel from acid solutions of protactinium was studied. From 1 to 10M HNO_3 and from 1 to 6M $HClO_4$ solutions, 90% adsorption took place, independently of acid concentration. The distribution coefficient is 3.440. Adsorption from hydrochloric and from sulfuric acid media decreased when acidity increased. Adsorption followed a Freundlich isotherm and the silica gel capacity in 6M HNO_3 is 0.11 milligram-atom of Pa per gram of silica gel. Desorption may be achieved with solutions of complexing agents, both organic (oxalic, citric, tartaric acids) and inorganic (H_3PO_4, H_2O_2). Selective adsorption of protactinium from 6M HNO_3 solution was utilized for the separation of ^{233}Pa from neutron-irradiated thorium. The formula and the formation constants of some protactinium complexes were derived from distribution data on the adsorption of ^{233}Pa by silica gel from acid solutions containing HCl, $(NH_4)_2SO_4$, $H_2C_2O_4$, and $(NH_4)_2HPO_4$. (auth)

8322 STUDIES OF THE BEHAVIOR OF PROTACTINIUM IN SULFURIC ACID. Campbell, D. O. (Oak Ridge National Lab., Tenn.). pp 209-24 of Physico-Chimie du Protactinium. Paris, Centre National de la Recherche Scientifique, 1966.

The chemistry of protactinium in sulfuric acid solutions was studied, utilizing primarily the solvent extraction method. Emphasis was placed on the behavior at relatively high protactinium concentrations, up to several mg/ml. Data are reported for extractions into 0.03M trilaurylamine from 2.5, 3.2, and 4.17M sulfuric acid. In all cases a reasonably constant extraction coefficient was observed if the protactinium concentration in the aqueous phase was below about 0.004 mg/ml, but at higher concentrations extraction increased sharply. Above 0.01 mg/ml consistent extraction coefficients were observed for the higher acid concentrations, but for 2.5M acid results were not reproducible. Rates of extraction were very slow for the higher protactinium concentrations. The change in extraction behavior with protactinium concentration is interpreted in terms of the existence of several species which are probably polymeric in protactinium. At least two of these were extractable, but the species formed at higher protactinium concentrations were inextractable although they reach equilibrium with the extractable species very slowly. Preliminary results are presented for measurements of the ultraviolet absorption spectra. Three different spectra were observed for protactinium in concentrated sulfuric acid, depending on the source of protactinium. This indicates that the spectra may yield some evidence about species in these solutions. (auth)

8323 STUDY OF THE OXIDES AND THE PEROXIDE OF PROTACTINIUM. Stchouzkoy, Tatiana; Pezerat, Henri; Muxart, Roland (Institut du Radium, Arcueil, France. Institut de Recherche Chimique Appliquee, Paris). pp 61-72 of Physico-Chimie du Protactinium. Paris, Centre National de la Recherche Scientifique, 1966. (In French).

The composition of hydrated protactinium oxide, prepared by precipitation from sulfuric acid solutions (either by dilution or by addition of ammonia) followed by washing and drying, was investigated. The product was hygroscopic. The proportion of bound water was variable and depended on the conditions of the preparation. Thermogravimetric analyses in air, at atmospheric pressure, did not show any evidence for the existence of definite hydrates of protactinium pentoxide. Hydrated oxide precipitated by hydrolysis strongly adsorbed sulfate ions. The crystal structure of protactinium oxide was investigated as a function of the method of preparation (calcination of hydrated oxide, calcination of peroxide), the temperature of calcination, and the nature of the atmosphere (calcination in air, calcination in oxygen). Three crystalline phases were observed and their lattice parameters determined. The compound that precipitated from a diluted sulfuric acid solution of protactinium on addition of H_2O_2 was a peroxide corresponding to the formula Pa_2O_9, $3H_2O$. The compound was instable and decomposed at room temperature even in absence of light. The decomposition, which was fast, followed first order kinetics with a period that depended on the nature of the liquid utilized for the washing of the peroxide. Thermogravimetric study of the peroxide, in air, under atmospheric pressure, supported the existence of a monohydrated protactinium pentoxide, stable between 200 and 280°C. Protactinium peroxide was amorphous, even when freshly precipitated. (auth)

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Refer also to abstracts 8408, 8625, and 9930.

8324 (AAEC-E-154) LABORATORY DEVELOPMENT OF THE GRIND-LEACH PROCESS FOR THE H,T,G,C,R. FUEL CYCLE. PART 2. DISSOLUTION OF BERYLLIA IN NITRIC ACID SOLUTIONS. Farrell, M. S.; Isaacs, S. R.; Shying, M. E. (Australian Atomic Energy Commission Research Establishment, Lucas Heights). June 1966. 28p. Dep. mn.

The development of the grind–leach process for the processing of beryllia-based fuels requires a knowledge of the dissolution of beryllia in nitric acid. A kinetic study using powdered specimens proved suitable for the investigation of this system. The parameters studied include particle size, agitation, temperature, acid concentration, the effect of the addition of fluoride and aluminum, and the effect of neutron irradiation of the beryllia. The dissolution of beryllia in nitric acid is controlled by a chemical reaction at the surface of the solid and has an apparent activation energy of 18 kcal/mole. (auth)

8325 (AECL-2641) THE RADIATION AND THERMAL DECOMPOSITION OF TERPHENYLS AND HYDROTERPHENYLS. A Summary of Canadian Experience. Tomlinson, M.; Boyd, A. W.; Hatcher, S. R. (Atomic Energy of Canada Ltd., Pinawa (Manitoba). Whiteshell Nuclear Research Establishment). May 1966. 23p. (CONF-660553-2). Dep. mn. AECL $1.00.

From Panel on Use of Organic Liquids as Reactor Coolants and Moderators, Vienna, Austria.

Studies of the radiation and thermal decomposition of terphenyls and a hydrogenated terphenyl mixture are summarized. At temperatures up to 350°C the radiolytic decomposition of terphenyls: was independent of radiation intensity, increased slightly with temperature, and was several times greater for recoil proton radiation than for fast electrons. Above 350°C the decomposition rate during irradiation: was greater at low intensities than at high intensities, increased more rapidly with increasing temperature, was independent of the kind of radiation, and increased with increasing radiation pulse frequency. These effects were interpreted in terms of changes in the radiolytic mechanism at higher temperatures. HB-40, a hydrogenated terphenyl, was subjected to prolonged irradiation in a small loop under conditions simulating use in a reactor. Decomposition products were removed by batch distillation and recovered coolant was recycled to attain various stationary compositions. These HB-40 coolant mixtures differed in important respects from the HB-40 feed. Rates of consumption of coolant were low, in the range 15 to 20 grams consumed per kWh radiation absorbed, at temperatures in the range from 250 to 400°C. Thermal degradation of the radiolytic high-boiler products at higher temperatures or irradiation or distillation tended to offset the radiolytic decomposition. (auth)

8326 (JINR-P13-3019) ISSLEDOVANIE DIFFUZII PRODUKTOV YADERNYKH REAKTSII V METALLAKH I OKISLAKH. (Investigation of the Diffusion of the Nuclear Reaction Recoil Products in Metals and Oxides). Amov, B.; Permyakov, V. P.; Tarantin, N. I. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Reactions). 1966. 14p. (In Russian). Dep. mn.

Emission and thermoionization characteristics of different oxide compounds and of some metals caused by nuclear recoil products trapped into them were investigated. The experiments were carried out to choose emitters or thermoionizers for ion sources of on-line electromagnetic separators. (auth)

8327 (LFEN-49) REDUCAO DO SULFATO CERICO EM PRESENCA DE IOES TALOSOS. REPARTICAO INTRATRAJECTORIA DOS PRODUTOS PRIMARIOS DE RADIOLISE. (Reduction of Cerium Sulfate in the Presence of Thallium Ions. Intra-Trajectory Distribution of Primary Products of Radiolysis). Mariano, M. Helena; Novais, Horacio M. (Junta de Energia Nuclear. Laboratoria de Fisica e Engenharia Nucleares, Sacavem). 1966. 22p. (In Portuguese). Dep. mn.

The curve which represents the variation of the reduction yield of ceric sulfate by α particles from dissolved ^{210}Po as a function of the concentration of thallous ions has a maximum $G(Ce^{3+})_{Tl^+}$= 3.40 for $Tl^+ = 2 \times 10^{-4}$ M. The difference between the maximum value obtained and the theoretical value corresponding to the total capture of OH by the thallous ion is attributed partially to the inhibition of the inverse reaction of the radiolysis product in the second heterogeneity zone of the trajectories of α particles and partially to the reaction of a fraction of Tl^{2+} produced at the interior of the trajectory by the reaction $OH + Tl^+ \rightarrow Tl^{2+} + OH^-$ with hydrogen peroxide before scattering by the solution. It was verified that the experimental points obey the expression $G(Ce^{3+})_{Tl^+} = 2G(H_2O_2)_{Tl^+} + 2G(Tl^{3+})$, if $G(H_2O_2)_{Tl^+}$ is the yield of hydrogen peroxide in solutions of Tl_2SO_4 without other solutes and $G(Tl^{3+})$ is the oxidation yield of the thallous ion. It was deduced that at the interior of the trajectory in the zone of OH recombination the mean concentration of these radicals is of the order of 10^{-1} M and that the second heterogeneity zone has a volume 100 times larger than it. (tr-auth)

8328 (NYO-3657-1) THEORETICAL RESEARCH ON RADIATION INDUCED DEFECTS IN LiH. Progress Report. Hatcher, Robert D. (Queens Coll., New York. Dept. of Physics). Dec. 1966. Contract AT(30-1)-3657. 54p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Two quantum-mechanical methods are given for calculating interaction energies between the separate ions. The method of off-center ions was also used to study the interaction of Li^+ with other ions. Methods are described for calculating the properties of neutral and charged defects. The theory of nuclear quadrupole resonance is described with its application to Li^+ ions in an ionic crystal. A calculation of interstitial He in LiH was made to test the method. The problem of the large polarizability of H^- is considered. (D.L.C.)

8329 (ORNL-4051) PREPARATION OF ^{33}P BY IRRADIATION OF ENRICHED ^{33}S IN HIGHLY THERMALIZED FLUX. Lewis, R. E.; Reynolds, S. A. (Oak Ridge National Lab., Tenn.). Jan. 1967. Contract W-7405-eng-26. 7p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Millicurie quantities of carrier-free ^{33}P containing <1% ^{32}P were prepared by neutron irradiation of enriched sulfur targets (61.15 and 68.1% ^{33}S) in a highly thermalized neutron flux. Target irradiation conditions and radionuclide yields are given, and the chemical recovery procedure and analytical methods are described. (auth)

8330 (AEC-tr-6806) ANNUAL REPORT OF THE JAPANESE ASSOCIATION FOR RADIATION RESEARCH ON POLYMERS, VOLUME 6, 1964–1965. Translation of Nippon Hoshasen Kobunshi Kenkyu Kyokai Nempo, 6: 1-322(1964–1965). 365p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The English-language portions of the report, including abstracts and entire articles, are reproduced in their original form. Thirty-three articles, which were previously abstracted in NSA from the original language, are included. (P.C.H.)

8331 UNIVERSAL ULTRAVIOLET BAND IN EXTRA-ABSORPTION SPECTRA OF MeF_2-TR^{3+} CRYSTALS EXPOSED TO γ RADIATION AT 77°K. Arkhangelskaya, V. A.; Alekseeva, L. A. Opt. Spektros., 21: 93-5(1966). (In Russian).

Extra-absorption spectra of fluorite-type crystals MeF_2 (Me–Ca, Sr, Ba), activated with trivalent rare earth ions (TR^{3+}) and irradiated with γ rays at 77°K, display (in addition to the known bands belonging to TR^{2+} ions formed during the irradiation) a very strong absorption in the near ultraviolet. Heating of the crystals to 300°K caused the band to disappear. The broad structureless band ($\Delta_{\frac{1}{2}} \approx 6500\ cm^{-1}$ at 77°K) whose maximum is at about 315 nm in CaF_2, 325 nm in SrF_2, and 345 nm in BaF_2 crystals was undoubtedly due to defects inherent in the MeF_2 structure, since its position depends on neither the type nor the concentration of the rare earth activator introduced. However, the intensity of this band at a given irradiation dose as well as the intensity of the TR^{2+} bands increased with the TR^{3+} concentration. The faint colorability of MeF_2 crystals was found to be determined not only by the high energy of the lattice bond, but also by the thermal instability of the color centers formed. The "sign" of the observed universal band of extra absorption of fluorides was studied on x-irradiated CaF_2-Dy crystals by determining the optical decolorization. Radiation with $\lambda = 365$ nm at 77°K caused the destruction of Dy^{2+} centers, indicating a hole origin of the universal uv band of MeF_2. Whereas the decrease in the absorption of TR^{2+} centers may be due to recombination with holes, the increase of absorption in the shortwave range may be due to the recapture of free holes (formed by the decay of the autocatalyzed state) by the lattice defects of MeF_2. (ATD)

8332 ORIENTED ATTACK OF CRYSTALS OF SILVER BROMIDE EXPOSED TO AN ELECTRON BEAM. Mailliet, Anne-Marie; Pouradier, Jacques (Centre de Recherches, Vincennes, France). Compt. Rend., Ser. C, 263: 1344-7(Nov. 28, 1966). (In French).

An electron microscopic study was made of the decomposition of tabular crystals of silver bromide exposed to an electron beam. The photolysis attacked locally the crystals studied by creating generally hexagonal cavities whose boundaries were parallel to the ⟨211⟩ direction of the crystal. (tr-auth).

8333 INTRAMOLECULAR ACTIVITY DISTRIBUTION IN PICOLINE LABELED WITH RECOIL ATOMS OF ^{14}C. Firsova, L. P.; Nesmeyanov, An. N.; Barakat, M. F. Radiokhimiya, 8: 379-82(1966). (In Russian).

The intramolecular activity distribution of ^{14}C recoil atoms in picoline obtained by the irradiation of pyridine, picoline, and their mixtures with toluene was studied. The intramolecular

activity distribution observed was explained by the superthermal reactions with the formation of metastable complexes, proceeding parallel with the thermal reactions and the elastic collision reactions. It was found that the intramolecular activity distribution in the products, the formation of which is possible by superthermal mechanisms, in binary systems depended on the composition of the system. (tr-auth)

8334 DETECTION OF TRICHLOROMETHYLCHLOROPHOSPHINIC-^{32}P ACID IN NEUTRON IRRADIATED CARBON TETRACHLORIDE. Gabov, N. I.; Shafiev, A. I. Radiokhimiya, 8: 330-3(1966). (In Russian).

By the method of paper chromatography it was found that in the hydrolyzed stabilization products of radioactive phosphorus in carbon tetrachloride, phosphates (33%), phosphites (33%), and trichloromethylchlorophosphinic acid (12%) were present. (tr-auth)

8335 REACTIONS OF ^{14}C RECOIL ATOMS IN BINARY SYSTEMS CONTAINING HETEROCYCLIC COMPOUNDS. Firsova, L. P. Radiokhimiya, 8: 333-41(1966). (In Russian).

The question on the discrepancy in the size of the radiochemical yield of products, labeled with recoil atoms, in binary systems from the size calculated by the additivity rule was examined taking into consideration the secondary chemical reactions, processes of energy transmission, effectiveness of the slowing down, and difference in the reaction cross section of recoil atoms with the molecules of the components. It was found that the concentration dependences, caused by the secondary processes, can be described by parabolic equations, whereas the dependence of the yield on the concentration, connected with the effectiveness of the slowing down and the difference in the efficiency of the primary chemical interactions of recoil atoms, can be approximately described by fraction-linear functions, which correspond to the hyperbola. Functions, determining the size of the indicated effects, were evaluated for the binary system containing heterocyclics. (tr-auth)

8336 RADIOCHEMICAL SYNTHESIS OF LABELED CARBONYL AND CARBOXYL COMPOUNDS WITH HYDROCARBON BASE AND LABELED CARBON OXIDES. Kalyazin, E. P.; Nesmeyanov, An. N.; Bakh, N. A. Radiokhimiya, 8: 341-7(1966). (In Russian).

A method for the quantitative preparation of the radioactive gases ^{14}CO and $^{14}CO_2$ in hydrocarbon solution without a gaseous phase was developed. It was found that during the irradiation of ^{14}CO and $^{14}CO_2$ solutions in heptane under stationary conditions, labeled carbon monoxide can be converted into carbonyl compounds by 30% and carbon dioxide can be converted into carboxyl compounds by 50%. Methods for detecting radiation synthesis products by their adsorption on silica gel and for determining the activity of the adsorbed products are proposed. During irradiation of the ^{14}CO and $^{14}CO_2$ solutions with continuous detection of the products from the reactor irradiation zone, almost complete conversion of the original activity was attained. The molar activity of the radiochemical synthesis agrees with the molar activity of the original alcohol. It was found that ^{14}C atoms existed in carbonyl and carboxyl groups. (tr-auth)

8337 EFFECTS OF SOLUTE CONCENTRATION AND pH ON RADICAL AND MOLECULAR YIELDS IN X-IRRADIATED AQUEOUS SOLUTION. Dainton, F. S.; Gibbs, A. R.; Smithies, D. (Univ. of Leeds, Eng.). Trans. Faraday Soc., 62: 3170-82(Nov. 1966).

The effects of solute concentration and pH on the yields of products from x-irradiated aqueous solutions containing 2-propanol + N_2O, $Fe(CN)_6^{4-}$ + $Fe(CN)_6^{3-}$ + N_2O, and NO_2^- + N_2O were measured. Radical yields increased with increase of solute concentration and at pH > 11. These results are interpreted in terms of conversion of H to e_{aq}^- at high pH and reaction of a species other than e_{aq}^-, possibly an excited water molecule, with N_2O. (auth)

8338 RADIOLYSIS OF LIQUID VINYL IODIDE BY ^{60}Co γ-RAYS. Herman, Jan A.; Roberge, Pierre C. (Laval Univ., Que.). Trans. Faraday Soc., 62: 3183-8(Nov. 1966).

The ^{60}Co γ irradiation of pure liquid vinyl iodide yielded the following products, the corresponding G values being given in brackets: hydrogen (0.077), acetylene (3.89),ethylene (1.46), 1,3-butadiene (0.15), hydrogen iodide (0.63), iodine (2.48), and also two minor non-identified compounds. There was no formation of polymers even after prolonged irradiation. (auth)

8339 EFFECT OF TEMPERATURE ON THE NEUTRALIZATION OF HYDRONIUM IONS IN THE RADIOLYSIS OF WATER VAPOR. Johnson, G. R. A.; Simic, M. (Univ. of Newcastle-upon-Tyne, Eng.). Nature, 212: 1570-1(Dec. 31, 1966).

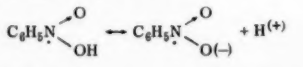
Deuterium oxide was irradiated in the presence of light cyclohexane at 200 to 400°C by a 1000 ^{60}Co γ source. Within experimental error, $G(HD)_t$ was found to be independent of the temperature between 140 and 390°C, both in the absence and presence of SF_6. The yield of protium (H_2) was markedly dependent on temperature, increasing from $G(H_2)_t = 0.9$ at 140°C to 15.5 at 400°C. $G(H_2)_t$ was not affected by the addition of SF_6. Deuterium (D_2) was also formed, and the yield, $G(D_2)_w = 0.60 \pm 0.05$ (molecules/100 eV absorbed by D_2O), was independent of temperature and unaffected by SF_6. It was concluded that the yield of D atoms from D_2O vapor is independent of the temperature of radiolysis, at least between 100 and 400°C, and that the recombination, hydronium ion + electron, gives one atom of D per ion over the whole temperature range. Thus, if the extent of hydration of the hydronium ion does change over the temperature range considered, this change does not have any measurable effect on the radiolytic decomposition of water. (P.C.H.)

8340 PULSE RADIOLYTIC INVESTIGATION OF THE OXIDATION AND REDUCTION OF NITROSOBENZENE IN AQUEOUS SOLUTIONS. Asmus, K.-D.; Beck, G.; Henglein, A.; Wigger, A. (Hahn-Meitner-Institut fuer Kernforschung, Berlin). Ber. Bunsenges. Physik. Chem., 70: 869-74(Nov. 1966). (In German).

Intermediate products of the oxidation and reduction of nitrosobenzene were investigated by following their optical absorption and conductivity. The OH radical forms $C_6H_5NO_2^-$ + H^+ in its reaction with nitrosobenzene ($k = 1.1 \times 10^{10}$ M^{-1} sec^{-1}). The hydrated electron reacts with nitrosobenzene to yield $C_6H_5NO^-$ ($k = 4.3 \times 10^{10}$). The pK-value of the equilibrium $C_6H_5NOH \rightleftharpoons C_6H_5NO^-$ + H^+ was equal to 11.7. The optical absorption spectra of C_6H_5NOH and $C_6H_5NO^-$ are described. Alcohol radicals in both their acid and basic forms reduce nitrosobenzene. Several rate constants of these processes were measured. CO_2^- transfers an electron to C_6H_5NO ($k = 4.0 \times 10^8$). $C_6H_5NO_2$ reacts with C_6H_5NOH or $C_6H_5NO^-$ to form nitrobenzene and phenylhydroxylamin ($k = 2.1 \times 10^8$, and 10^8, respectively). C_6H_5NOH and $C_6H_5NO^-$ disappear by mutual deactivation. A species absorbing at 3300 Å is produced in this reaction. The rate constant is dependent on the pH-value of the solution ($\sim 5 \times 10^5$ at pH = 7). (auth)

8341 PULSE RADIOLYTIC INVESTIGATIONS OF SOME ELEMENTARY PROCESSES OF NITROBENZENE REDUCTION. Asmus, K.-D.; Wigger, A.; Henglein, A. (Hahn-Meitner-Institut fuer Kernforschung, Berlin). Ber. Bunsenges. Physik. Chem., 70: 862-8(Nov. 1966). (In German).

The hydrated electron reacts with nitrobenzene to form $C_6H_5NO_2^-$. The optical absorption spectrum of this particle was determined (ϵ_{max} at 2850 Å = 1.4×10^4 $mole^{-1}$ liter cm^{-1}). $C_6H_5NO_2H$ predominantly exists in acid solutions (ϵ_{max} at 2750 Å = 9250 $mole^{-1}$ cm^{-1}). The pK value of the equilibrium



amounts to 3.2. $C_6H_5NO_2^-$ is rather stable in alkaline solutions (lifetime: several seconds). $C_6H_5NO_2H$ disappears from acid solutions by disproportionation with $2k = 6 \times 10^8$ $mole^{-1}$ liter sec^{-1}. The resulting particle $C_6H_5N(OH)_2$ decays by splitting off water to form nitrosobenzene. The unimolecular rate constant of this decay depends on the proton concentration according to $k = a\sqrt{[H^+]} + b$ (a and b: constants). The $C_6H_5NO_2^-$ ion is able to transfer an electron to nitrosobenzene with $k = 4.1 \times 10^7$ $mole^{-1}$ liter sec^{-1}. The free H-atom does not reduce the nitro-group of nitrobenzene but adds to the aromatic ring to yield the nitro-cyclohexadienyl radical. $C_6H_5NO_2^-$ is also formed in the reaction of α-alcohol radicals with nitrobenzene. The basic forms of the α-alcohol radicals react with $k = 3 \times 10^9$ $mole^{-1}$ liter sec^{-1}. This rate constant is practically independent of the structure of the alcohol. The acid forms react slower with nitrobenzene. The rate of electron transfer increases with Taft's σ^*-value for the inductive effect of the group R_1R_2CH in the alcohol R_1R_2CHOH. (auth)

8342 IONIC POLYMERIZATION UNDER ELECTRIC FIELDS. II. RADIATION-INDUCED POLYMERIZATION OF STYRENE. Sakurada, Ichiro; Ise, Norio; Kawabata, Seiji (Kyoto Univ.). Makromol. Chem., 97: 17-30(1966).

Cationic polymerization of p-methoxystyrene with iodine in ethylene dichloride was accelerated and the degree of polymerization increased by the presence of a strong electric field, but the radical polymerizations of styrene and methyl methacrylate were not affected. A comparison was made of types of polymerization with radioinduced polymerization in terms of the influence of electric field. Thus the ^{60}Co γ-radioinduced polymerization of styrene was carried out at −78°C in methylene chloride under a strong electric field. The rate of polymerization was enhanced in the presence of electric field whereas the degree of polymerization remained virtually unaffected. It was pointed out that the enhancement of the rate could be accounted for by the increase of ion yield due to the field, assuming a free-ion mechanism. The electric

conductivity of the polymerizing solution could be attributed mainly to electrolyte produced by solvent radiolysis. In experiments with ethylbenzene and toluene instead of methylene chloride, which are believed to be fairly stable to the radiation, the conductivity of the solutions was measured. From the measurements, the average lifetime of ions supposedly originating from styrene molecules was estimated to be 10^{-1} to 10^{-2} sec; these ions are believed to be responsible for the radioinduced polymerization. (BBB)

8343 RECOVERY BEHAVIOR OF SINGLE FIBERS OF RADIATION-INDUCED GRAFT COPOLYMERS OF CYANOETHYLATED COTTON AND ACRYLONITRILE. Arthur, Jett C. Jr.; Grant, James N. (Dept. of Agriculture, New Orleans). Textile Res. J., 36: 934-5(Oct. 1966).

Compared with the properties of purified cotton yarns and cyanoethylated cotton yarns, radioinduced graft copolymer yarns of cyanoethylated cotton and acrylonitrile had increased elongation-at-break and delayed elastic recovery, and decreased permanent set, average stiffness, and solubility of the cellulose in 0.5M cupriethylenediamine. Since yarn behaviors are complicated by construction effects, fibers were removed from the yarns and their load-elongation and recovery properties were measured. The yarns were prepared from purified cotton, purified cotton cyanoethylated to D.S. 0.7, and graft copolymer of cyanoethylated cotton (D.S. 0.7) and acrylonitrile, prepared by the simultaneous ^{60}Co irradiation technique at a dose of 1.0 MR, yielding a fibrous cotton product containing 38% polyacrylonitrile. The load-elongation curves for single fibers from each of these yarns are illustrated. For the modified cottons, the slopes of the curves are slightly greater than for the purified cotton. Permanent set as a function of strain (percentage of elongation-at-break) for single fibers from each of these yarns is also shown. Over the entire range of strains examined, the fibers from the graft copolymer yarns had a lower permanent set than either of the other fibers. As the strain increased, permanent set increased for all of the fibers. The permanent sets for the fibers were lower than for their yarns at low strains but exceeded slightly those for yarns at greater than 50% of elongation-at-break. As shown by electron micrographs of ultrathin cross-sections of the graft copolymer of cyanoethylated cotton and polyacrylonitrile, the graft polymer was deposited within the structure of the cotton fiber. During the grafting process, the cotton fiber was swollen by the action of the solvent (aqueous 80% $ZnCl_2$) used for the acrylonitrile monomer. The radioinduced graft copolymerization formed high molecular-weight polyacrylonitrile within this swollen structure. (BBB)

8344 INVESTIGATION OF THE RADIATION STABILITY OF ALKYL DIPHENYLS. Roder, Magda; Kules, Inna; Kiss, Istvan (Central Research Inst. for Physics, Budapest). Magyar Kem. Foly., 72: 443-7(Oct. 1966). (In Hungarian).

The effects of 6 to 9×10^{21} eV/g hr radiation dose on the stability of diphenylmethane, isopropyl diphenyl, and n-propyl diphenyl were investigated, characterizing the effects by the amount of gas evolved and polymer formed. The protective effect of the aromatic group decreased with increasing carbon-atom number in the side chain. The isopropyl derivative was more stable than was the n-propyl derivative. The data are of interest since these alkyl diphenyls are potential reactor coolants and/or moderators. It appears that the radiation stability of alkyl diphenyls is the greatest if the aliphatic portion is located between two aromatic groups. (JPRS)

8345 INVESTIGATIONS ON THE EFFECT OF ENERGETIC RADIATION ON THE DIELECTRIC BEHAVIOR OF POLYVINYLCHLORIDE. Kiessling, D. (Institut fuer Physik und Physikalische Chemie der Hochpolymeren, Leipzig). Monatsber. Deut. Akad. Wiss. Berlin, 8: 304-9(1966). (In German).

The effects of energetic radiation up to 150 MRAD on the dielectric behavior of polyvinyl chloride were investigated. The results showed that the experimental activation energy for the β process decreases rapidly with increasing dose and tends to a limiting value at even small doses, but the activation energy for the α process passes through a minimum. The probable mechanism is discussed. (J.S.R.)

8346 ELECTRON TRAPPING IN γ-IRRADIATED ORGANIC GLASSES. Ershov, B. G. (Inst. of Physical Chemistry, Moscow); Moorthy, P. N.; Lingam, K. V. Indian J. Chem., 4: 494-6 (Nov. 1966).

Gamma-irradiated glassy specimens of glycerol and ethylene glycol attained a deep pinkish blue color and gave a singlet ESR spectrum. These properties were attributed to trapped electrons. This interpretation is supported by the effect of electron scavenger solutes (e.g., acetone) on these two characteristics. (auth)

8347 RADIORESISTANCE AND DELOCALIZATION OF π ELECTRONS. Van de Vorst, A.; Richir, M.; Rajalakshmi, K. V. (Univ., Liege. Institut d'Astrophysique, Cointe-Sclessin, Belg.). Bull. Cl. Sci., Acad. Roy. Belg. (5), 52: 276-95(1966). (In French).

The degree of validity of the empirical rule that makes the radioresistance of conjugated molecular systems, in the solid phase, depend on the degree of delocalization of the π electrons that characterize them was analyzed. The discussion is centered on the hydrocarbons, the conjugated heterocyclics, and their substituted derivatives. In order to complete the ensemble of previously known values of the radiolytic yield, the radical yields, of the three groups of substances including halogen derivatives with variable degree of substitution were determined by electron spin resonance. The substances studied were tyrosine, thyronine, their respective iodide derivatives, and uracil and its halogen derivatives. (tr-auth)

8348 EFFECT OF IMPURITY AND REACTION CONDITION ON THE DOSE RATE DEPENDENCE OF TELOMERIZATION RATE OF ETHYLENE WITH CARBON TETRACHLORIDE INDUCED BY γ-RADIATION. Takehisa, Masaaki; Urano, Yokichi; Yasumoto, Masahiko. Tokyo Kogyo Shikensho Hokoku, 61: 457-61(Nov. 1966). (In Japanese).

The dose-rate dependence of the rate of telomerization varies considerably with the reaction conditions. The following rate equations were derived from the assumption that an inhibitor of a free radical reaction as an impurity in a commercial ethylene might be responsible to the dose rate dependence of the rate of the telomerization. $1/(dM/dt) = A\{B + [\sqrt{1 + (x/1 - x)(M_v^c/M_v)}]/[x/(1 - x)]\}$, where $A = k_2^{0.5}/(k_1 G_R^{0.5}[S_0]^{0.5} I^{0.5})$, $B = (k_1[S_0]^{0.5}C)/(k_2^{0.5} G_R^{0.5} I^{0.5})$, x = Mole fraction of C_2H_4, M_v = molar volume of CCl_4, M_v^c = molar volume of C_2H_4 in CCl_4, k_1 = rate constant for propagation, k_2 = rate constant for radical recombination, [S] = concentration of CCl_4, I = dose rate, G_R = radical yield, and C = mole fraction of inhibitor in fresh ethylene. The constants A and B can be determined from the experiments independently from the absolute values of G_R, k_1, k_2, and C. The dose-rate dependence of the rate of the telomerization derived from the rate equation as a function of B consisted with the experiments. (auth)

8349 OPTIMIZATION OF REACTION CONDITIONS AND REACTOR DIMENSIONS FOR A SYNTHESIS OF 1,1,1,5-TETRACHLOROPENTANE BY TELOMERIZATION OF ETHYLENE WITH CARBON TETRACHLORIDE INDUCED BY γ-RADIATION. Takehisa, Masaaki. Tokyo Kogyo Shikensho Hokoku, 61: 468-77(Nov. 1966). (In Japanese).

A series of $\alpha,\alpha,\alpha,\omega$-tetrachloroalkanes, especially 1,1,1,5-tetrachloropentane, is obtained by telomerization of ethylene with carbon tetrachloride induced by γ radiation under pressure. Optimum reaction conditions and dimensions of concentric type reactor were calculated for 10 t/day 1,1,1,5-tetrachloropentane production plant under appropriate assumptions. Results were: reaction temperature, 75°C; reaction pressure, 46 kg/cm^2; reactor diameter, 0.2×0.8 m; reactor length, 10 m; number of reactors, 2; radiation source (^{60}Co) intensity, 0.1 kW/m; impurity (radical reaction inhibiting material) concentration in a fresh feed ethylene, 15 ppM (NO as a standard); per pass conversion of carbon tetrachloride, 53%. (auth)

8350 TELOMERIZATION OF PROPYLENE WITH CARBON TETRACHLORIDE INDUCED BY γ-RADIATION. Takehisa, Masaaki; Urano, Yokichi; Yasumoto, Masahiko. Tokyo Kogyo Shikensho Hokoku, 61: 478-86(Nov. 1966). (In Japanese).

The rate of telomerization was determined dilatometrically in the following conditions; temperature, 10 to 70°C; pressure, 150 to 1,000 mmHg; dose rate, 2×10^3 to 7×10^3 RAD/hr. By a proposed rate equation, which was derived with a consideration of a degradative chain transfer to propylene, the ratio of the rate constants of the hydrogen abstraction from propylene by a chain-carrying radical, which produced stable allyl radical, to the addition reaction of propylene with a chain-carrying radical was found to be in the range from 0.002 (70°C) to 0.01 (10°C). The apparent activation energy of the hydrogen abstraction and addition reactions were nearly 0 and 5.3 kcal/mole, respectively. Distribution of the products observed by a gas chromatographic analysis clearly indicated the formation of the various minor products, such as isopropyl chloride, allyl chloride, hexadiene-1,5, chloroform, 4,4,4-trichlorobutene-1, and 1,1,1-trichlorobutane, which originated from the degradative chain transfer reactions. The G-values of these products gave a satisfactory agreement with the ratio of the rate constants obtained from kinetic studies. The degradative chain transfer constants and the fate of the allyl radical were discussed. (auth)

8351 TELOMERIZATION OF ETHYLENE WITH CYANOGEN CHLORIDE INDUCED BY γ-RADIATION. Takehisa, Masaaki; Hosaka, Yoshinobu. Tokyo Kogyo Shikensho Hokoku, 61: 501-2 (Nov. 1966). (In Japanese).

Telomerization of ethylene with cyanogen chloride induced by γ-radiation was carried out at 10 to 60°C, pressures of 60 to 185 kg/cm², reaction durations of 65 to 120 hr, and dose rate of 1.4×10^5 RAD/hr. A series of telomers, $Cl(C_2H_4)_nCN$, where n is integers between 2 and 4, was obtained and yields quantitatively determined by gas chromatography. Sum totals of the G-values of the telomer formation were around 10 regardless of the reaction conditions. Addition of NaCN to the reaction system increased the yield of the telomer formation around 2 fold, but the addition of azo-bis-isobutyronitrile had no effect. Essentially the same distribution of the degree of the telomerization compared with the conventional processes was observed. (auth)

8352 POLYMERIZATION OF BUTADIENE SULFONE. Minoura, Yuji; Nakajima, Shigemitsu (Osaka City Univ.). J. Polym. Sci., Pt. A-1, 4: 2929-44(Dec. 1966).

Polymerization of butadiene sulfone ($BdSO_2$) by various catalysts was studied. Azobisisobutyronitrile (AIBN), butyllithium, tri-n-butylboron (n-Bu)$_3$B, boron trifluoride etherate, Ziegler catalyst, and γ radiation were used as catalysts. Butadiene sulfone did not polymerize with these catalysts at low temperatures (below 60°C.), but polymers were obtained at high temperature with AIBN or (n-Bu)$_3$B. The polymerization of $BdSO_2$ initiated by AIBN in benzene at 80 to 140°C was studied in detail. The obtained polymers were white, rubberlike materials and insoluble in organic solvents. The polymer composition was independent of monomer and initiator concentrations and reaction time. The sulfur content in polymer decreased with increasing polymerization temperature. The polymers prepared at 80 and 140°C have the compositions $(C_4H_6)_{1.55}(SO_2)$ and $(C_4H_6)_{3.14}(SO_2)$, respectively, and have double bonds. These polymers were not alternating copolymers of butadiene with sulfur dioxide. The polymerization mechanism was discussed from polymerization rate, polymer composition, and decomposition rate of $BdSO_2$. From these results, the polymerization was thought to be "decomposition polymerization," i.e., butadiene and sulfur dioxide, formed by the thermal decomposition of $BdSO_2$, copolymerized. (auth)

8353 ESR SPECTRA OF TRAPPED ELECTRONS IN γ-IRRADIATED 3-METHYLPENTANE. Tsuji, Kozo; Yoshida, Hiroshi; Hayashi, Koichiro (Kyoto Univ.). J. Chem. Phys., 46: 810-11(Jan. 15, 1967).

Purified 3-methylpentane was sealed in an ESR sample tube under high vacuum. The samples were irradiated with γ rays from ^{60}Co (6×10^5 R/hr). ESR measurements were carried out mostly with a microwave power of about 1 mW. Immediately after irradiation (about 6 min), the sample showed ESR spectra composed of a widely spread 6-line spectrum and a sharp singlet line. This singlet spectrum may be due to the trapped electrons. (M.C.G.)

8354 STUDIES IN MASS SPECTROMETRY. V. FRAGMENTATION OF N-SUBSTITUTED MORPHINANS UNDER ELECTRON IMPACT. Mandelbaum, A.; Ginsburg, D. (Israel Inst. of Tech., Haifa). Israel J. Chem., 4: 149-54(Nov. 1966).

The fragmentation of N-substituted morphine under electron impact has been studied. The results showed that substitution affects the fragmentation pattern and the distribution of the charge in the fragments obtained by cleavage of doubly charged molecular ions. (auth)

8355 ANALYSIS OF THE EPR SPECTRA OF FLUOROCARBON RADICALS IN IRRADIATED TETRAFLUOROETHYLENE. Muromtsev, V. I.; Bruk, M. A.; Akhvlediani, I. G.; Asaturyan, R. A.; Zhidomirov, G. M.; Abkin, A. D. (Karpov Scientific Research Inst. of Physics and Chemistry, Moscow). Teor. Eksp. Khim., 2: 679-84(Sept.-Oct. 1966). (In Russian).

Studies of the EPR spectra of the gamma radiolysis of tetrafluoroethylene at 77°K showed the production of various type radicals. Two of the radicals were separated and interpreted to be fluorine atoms and CF_3–CF_2 radicals. (tr-auth)

8356 KINETICS OF HETEROGENEOUS MUTUAL RADIATION GRAFTING. Araki, K.; Kiho, H.; Stannett, V. (Research Triangle Inst., Durham, N. C.). Macromol. Chem., 95: 106-16(1966).

The mechanism of the diffusion-controlled grafting reaction is discussed, and a quantitative kinetic scheme is developed to help explain some grafting-time curves obtained experimentally. The grafting-time curves of heterogeneous mutual radiation grafting systems are often of the same type. There is a small auto-accelerative period after which the rate rises to a maximum and then levels off to a steady, lower rate. The grafting of styrene to wool fibers is shown to give this type of conversion curve. The reasons for this rate-time behavior have not been successfully explained although a number of kinetic treatments have been presented. The kinetic treatment reported postulates that the radical content continues to build up during the grafting process, leading to the gradual depletion of monomer in the substrate polymer and a final diffusion-controlled rate of grafting. This situation leads to the maximum rate type of grafting-time curve which is actually found. The necessary kinetic parameters were estimated for the two extreme portions of the grafting curve in the case of the wool – styrene system and further approximated by trial and error. Good agreement between the calculated and experimental rates of grafting was obtained. (BBB)

8357 RESEARCH ON COLOR CENTERS PRODUCED IN Ca-HALOPHOSPHATE PHOSPHORS BY THE IRRADIATION. PART 1. STUDIES OF COLOR CENTERS PRODUCED IN Ca-HALOPHOSPHATE MATRIX BY THE IRRADIATION BY VARIOUS RAYS. Kamiya, Shigeru; Shibata, Haruo (Matsushita Electronics Corp., Japan). Denki Kagaku, 33: 895-9(Dec. 1965). (In Japanese).

Color centers were formed by the irradiation of the fluorescent calcium halophosphate whose composition was $Ca/6PO_4 = 2.64$, $F + Cl/6PO_4 = 0.98$, and $F/Cl = 6$. An electron accelerator (600 keV), $K\alpha$ of Cu (1524 Å), a Tesla coil in a vacuum, and a mercury lamp made of quartz were used as radiation sources. The effects of irradiation time, radiation intensity, and of sample temperature were investigated. The position of the absorption band was not varied appreciably, but the intensity was influenced by the type of radiation source used. With prolonged irradiation, saturation began to appear, and a source of high radiant energy caused a large absorption intensity in a short time. The structure of the color center appeared to be closely connected with a vacant hole in the crystal. With irradiation using a Hg lamp of low pressure, the formation as exhibited by the 1850 Å line and the disappearance as exhibited by the 2537 Å line were in equilibrium. With increasing temperature, the color center concentration increased. The results of these experiments give support to the hypothesis that the color center is caused by the displacement of one halogen atom near the vacant hole with an oxygen atom. (NSA of Japan)

8358 GROWTH OF POTASSIUM CHLORIDE CRYSTALS FROM AQUEOUS SOLUTIONS. II. GROWTH IN A GAMMA-RADIATION FIELD. Botsaris, G. D.; Mason, E. A.; Reid, R. C. (Massachusetts Inst. of Tech., Cambridge). J. Chem. Phys., 46: 192-8(Jan. 1, 1967).

Seed KCl crystals were grown from aqueous solution under conditions of constant temperature, super-saturation, and impurity Pb^{2+} level. Experiments were carried out both in-and-outside a γ field. Dislocation densities and absolute-growth rates of the (100) faces of the KCl crystals were measured. With solutions containing about 10^{-7} moles $PbCl_2$/mole KCl, irradiation had no measurable effect on dislocation density. At lower lead concentrations, irradiation reduced the number of dislocations and a dislocation climb process is suggested to explain the results. The effect of irradiation on growth rates of KCl was insignificant when the Pb^{2+} concentrations were 10^{-8} and 10^{-6} moles/mole of KCl. At intermediate concentrations (around 10^{-7} moles Pb^{2+}/mole KCl), irradiation decreased the growth rate. A possible mechanism is suggested to explain the results. (auth)

8359 INVESTIGATION OF CHEMICAL EFFECTS OF $^{118}Sn(n,\gamma)^{119m}Sn$ REACTION AND THE FORM OF ^{119m}Sn STABILIZATION IN TIN DIOXIDES. Nesmeyanov, A. N.; Babeshkin, A. M.; Bekker, A. A.; Fano, V. Radiokhimiya, 8: 261-4(1966). (In Russian).

Effects of neutron irradiation on Sn^*O_2 were studied using stannic oxide enriched with 83.7% ^{118}Sn irradiated with 22×10^{13} neutron/cm² sec for 2 months. The chemical shifts of the spectrum studied showed the presence of SnO_3^{2-} and SnO_4^{4-}. The peaks corresponding to Sn^+ and Sn^{3+} were found with shifts of 0.5 mm/sec; however, their contribution was very small. (R.V.J.)

8360 PROPERTIES OF IRRADIATED-CROSSLINKED POLYETHYLENE CABLE. Tsuji, Y.; Tada, S.; Furuhashi, K. Sumitomo Denki, No. 92, 65-71(May 1966). (In Japanese).

Properties of irradiated-crosslinked polyethylene and electrical wire insulated with irradiation-crosslinked polyethylene are discussed. The conclusion is that irradiation-crosslinked polyethylene wire has properties equal to those of unirradiated polyethylene at room temperature and a lifetime of two to three years at 100°C. (auth)

8361 LUMINESCENCE PHENOMENA IN GAMMA-IRRADIATED PURE ALKANES AT 77 DEG K. Janssen, Onno; Funabashi, Koichi (Univ. of Notre Dame, Ind.). J. Chem. Phys., 46: 101-6(Jan. 1, 1967).

The effects of cracks on the annealing behavior of γ-irradiated, pure 3-methylpentane glass at 77°K were studied. Conclusions were reached that although cracks apparently accelerate the glass relaxation markedly, they are not required for the annealing effects to be observed. The luminescence spectra of isopentane were found to be different for glassy and polycrystalline states. It is also shown, using a simple model, that the lowest charge-

separated state can be stationary and lower in energy than the first excited state of the molecule; consequently, the charge-separated state can be the luminescent state for pure alkanes. (auth)

8362 ISOMERIZATION OF ALKYL CHLORIDES AND BROMIDES BY RADIATION. Takehisa, Masaaki; Levey, Gerrit; Willard, John E. (Univ. of Wisconsin, Madison). Contract AT (11-1)-32. J. Amer. Chem. Soc., 88: 5694-5700(Dec. 20, 1966). (COO-32-122).

The isomerization reactions induced by γ irradiation of n-C_3H_7Cl, i-C_3H_7Cl, n-C_4H_9Cl, i-C_4H_9Cl, sec-C_4H_9Cl, t-C_4H_9Cl, n-C_3H_7Br, and n-C_4H_9Br were investigated to determine which compounds undergo a hydrogen halide catalyzed chain isomerization and to elucidate further the mechanisms of such isomerizations. n-C_3H_7Cl, n-C_4H_9Cl, and i-C_4H_9Cl showed the catalyzed reaction, with high G values, but i-C_3H_7Cl, sec-C_4H_9Cl, t-C_4H_9Cl, and the bromides did not. Effects of dose, dose rate, concentration of additives (HCl, HBr, HI, I_2, DPPH, CH_3I), temperature, and phase on G values were studied. The apparent activation energy, obtained from measurements over the range from −78 to 100°C, was 3 kcal $mole^{-1}$. Hydrogen bromide, present at 1.2 mole % during the radiolysis of liquid n-C_3H_7Cl, had negligible catalytic effect at 25°C but was effective at elevated temperatures, while HI was ineffective, consistent with the relative activation energies for H abstraction by Cl, Br, and I. The ratios of i-C_3H_6TCl to n-C_3H_6TCl produced when liquid n-C_3H_7Cl was radiolyzed in the presence of TCl at −80 and 24°C were about 0.8 and 0.4, respectively; these are discussed in relation to the isomerization mechanism. G(isomerization) of n-C_4H_9Cl in both the glassy and polycrystalline states at −196°C was less than unity and was quite insensitive to HCl. In the gas phase at 25°C, HCl had a similar catalytic effect to that at the same molar concentration in the liquid phase. Radiation energy absorbed by the HCl did not initiate isomerization of the alkyl chloride. Neither HCl nor HBr catalyzed the isomerization of n-C_4H_9Br effectively, but G(isomerization), which was 19 at 25°C, rose to 80 at 100°C, indicating a chain isomerization occurring by a mechanism not involving hydrogen halide catalysis. The yields of 1,1-, 1,2-, 2,2-, and 1,3-$C_3H_6Cl_2$ from the photolysis and radiolysis of solutions of Cl_2 in n-C_3H_7Cl and i-C_3H_7Cl were determined to assist in the interpretation of the mechanism of isomerization. (auth)

8363 LABELING OF IODOBENZENE BY RADIOINDUCED ISOTOPIC EXCHANGE. Elias, H. (Technische Hochschule, Darmstadt, Ger.). Radiochim. Acta, 6: 107-9(Oct. 1966). (In German).

The preparation of iodine-labeled iodobenzene by radioinduced isotopic exchange was studied. Isotopic exchange and radiolysis in the $C_6H_5I-I_2$ system was investigated. The study showed that the radioinduced isotopic exchange between iodobenzene and iodine proceeds in the presence of air at room temperature faster than the radiolytic decomposition of iodobenzene. The smaller the I concentration is, the smaller is the dose necessary for attainment of a given exchange rate. At c_{I_2} = 0.0056 mol/l and after absorption of 2.4×10^6 r, the exchange rate equals 86%. No organic radiolysis products (benzene, biphenyl, diiodobenzene, and iodobiphenyl) are found in amounts of more than 0.1% and the iodobenzene contains these. The small amounts of organic radiolysis products can easily be separated after separation of the I_2 by fractional distillation or by gas chromatography. (J.S.R.)

8364 POSTIRRADIATION SCAVENGING IN THE RADIOLYSIS OF SOLID n-HEXADECANE. Falconer, W. E.; Salovey, R. (Bell Telephone Labs., Inc., Murray Hill, N. J.). J. Chem. Phys., 46: 387-8(Jan. 1, 1967).

Evidence is presented for postirradiation suppression of dimer by various solvents, supporting the hypothesis that the analogous dimer suppression by iodine present in the radiolysis of large normal paraffins is predominantly a chemical scavenging of radical precursors of the final products and that in solid-state radiolyses, the actual scavenging occurs on melting. Experiments were conducted with solid n-hexadecane irradiated to 4.2 Mrad with 1-MeV van de Graaff electrons at −78°C and then dissolved at temperatures below its melting point in 2-methyl-1-pentene, 2-methylpentane, 2-methylpentane with dissolved iodine, ethyl ether, and ethyl ether with dissolved iodine. In each case G (dimer) was reduced to virtually the same level as when dispersed iodine was present during irradiation. G for the dissolved sample was independent of the temperature of dissolution for all solvents except ethyl ether. (P.C.S.)

8365 ION–MOLECULE REACTIONS IN THE CONDENSED PHASE RADIOLYSIS OF HYDROCARBON MIXTURES. I. 2-METHYLBUTANE AND 2-METHYLPENTANE. Scala, A. A.; Lias, S. G.; Ausloos, P. (National Bureau of Standards, Washington, D. C.). J. Amer. Chem. Soc., 88: 5701-7(Dec. 20, 1966).

When cyclopropane-d_6 was added to i-C_5H_{12}, $CD_2HCD_2CD_2H$ was formed as a product with a yield that at 77°K increased as the square root of the cyclopropane-d_6 concentration from a G value of 0.117 at 0.03 mole % $(CD_2)_3$ to 1.53 at 20 mole % $(CD_2)_3$, while all lower perprotonated hydrocarbon product yields diminished proportionately. Addition of an electron scavenger such as CCl_4 to an i-$C_5H_{12}-(CD_2)_3$ (1:0.03) mixture increased G(CD_2HCD_2-CD_2H) to a value as high as 2.85 while the G values of products such as C_2H_6, C_2H_4, or C_3H_8 dropped by a factor of 5. Addition of CH_3OH reduced G($CD_2HCD_2CD_2H$). These observations can be accounted for by an H-transfer reaction such as $C_4H_{12}^+ + (CD_2)_3 \rightarrow C_3H_5^+ + CD_2HCD_2CD_2H$. An analogous reaction was shown to occur with a comparable efficiency when 3-methylpentane was substituted for 2-methylbutane in the reaction mixture. H_2-transfer reactions were shown to occur to small unsaturated compounds. The relative probabilities for the transfer of an H_2 entity from $C_5H_{12}^+$ to cyclopropane, ethylene, propylene, 1-butene, acetylene, and 2-butene are 2.4, 1.4, 1.0, 0.9, 0.77, and <0.1, respectively. A change in temperature from 77 to 300°K had relatively little effect on the yields of products resulting from H_2-transfer reactions. Experiments carried out with i-C_5H_{12}–i-C_5D_{12} and i-C_5D_{12}–i-C_6H_{14} mixtures indicated that charge transfer from i-$C_5D_{12}^+$ to i-C_6H_{14} was unimportant when more than 0.6 mole % of cyclopropane was present in the mixture. (auth)

8366 METHYL RADICAL IN IRRADIATED SINGLE CRYSTALS OF SODIUM ACETATE TRIHYDRATE. Rogers, Max T.; Kispert, L. D. (Michigan State Univ., East Lansing). J. Chem. Phys., 46: 221-3(Jan. 1, 1967).

ESR spectra of irradiated single crystals of sodium acetate trihydrate and three isotopically substituted species were examined at 77°K. The hyperfine proton and ^{13}C splittings provide strong evidence for the presence of trapped methyl radicals and the anisotropic hyperfine splitting tensors were evaluated and are discussed. The planar methyl radical is reorienting rapidly about its threefold axis. (auth)

8367 EVIDENCE ON THE ELEMENTARY REACTIONS IN THE RADIOLYSIS OF n-PROPYL CHLORIDE. Benson, Herbert L. Jr.; Willard, John E. (Univ. of Wisconsin, Madison). Contract AT(11-1)-32. J. Amer. Chem. Soc., 88: 5689-93 (Dec. 20, 1966). (COO-32-121).

Radiolysis of n-C_3H_7Cl by ^{60}Co γ rays produced HCl, 19 hydrocarbons, and organic chlorides with yields of 0.06 molecule per 100 eV or higher. The major product was i-C_3H_7Cl formed by an HCl-catalyzed chain isomerization of n-C_3H_7Cl where G(i-C_3H_7Cl) increased linearly with increasing HCl concentration. Other major yields were G(HCl) = 5, G(C_3 hydrocarbons) = 4.3, G($C_6H_{13}Cl_3$) = 1.6, G($C_3H_6Cl_2$) = 1.0, and G(H_2) = 1. With the exception of i-C_3H_7Cl, the yields were independent of total dose up to at least 6×10^{20} evg^{-1}. In the presence of I_2, C_3H_6, or C_2H_4, yields of the hydrocarbons and organic chlorides were all greatly reduced or eliminated and new products were formed. The photolysis of n-C_3H_7Cl gave products similar to those from the radiolysis. The data afford evidence on the contributions of the different free-radical processes. (auth)

8368 EXAMPLE OF THE PRODUCTION OF RADIONUCLIDES BY (γ,n) REACTIONS. Elias, H. (Technische Hochschule, Darmstadt, Ger.). Radiochim. Acta, 6: 109-10(Oct. 1966). (In German).

The radioisotopes ^{45}Ti, ^{58}Co, ^{106}Ag, ^{126}I, ^{132}Cs, ^{202}Tl, and ^{203}Pb were prepared by (γ,n) reactions in a linear accelerator. By determination of the half life and recording of the γ spectra, the occurrence and the extent of interferences by other nuclear photoreactions were determined. The only interfering reactions occurred in the preparation of ^{45}Ti by the formation of Sc isotopes by (γ,p) processes and ^{106}Ag by the formation of ^{105}Ag through (γ, 2n) reaction. (J.S.R.)

8369 APPLICATIONS DES RAYONNEMENTS EN FRANCE. [VOLUME I]. (Applications of Radiation in France. Volume I). [Gif-sur-Yvette, France, Centre d'Etudes Nucleaires de Saclay, 1966]. 235p.

Articles published in France in 1965 on the application of radiation are compiled. The first volume includes articles on irradiators and dosimetry, radiochemistry, radiobiology, and technological studies. Individual abstracts were prepared for 23 of the papers. The remaining 3 papers were previously abstracted for NSA and appeared as abstracts 19: 9182, 11626, and 26399. (J.S.R.)

For abstracts of individual papers see: 8370–8384, 8408, 8731, 9030, 9043–9045, 9259, and 9260.

8370 IRRADIATION BY ^{60}Co γ RAYS OF THE AMMONIUM SALT OF HEXANITRODIPHENYLAMINE. Bagno, Odette; Bonet-Maury, Paul (Institut du Radium, Orsay, France). pp 1-4 of Applications des Rayonnements en France. Vol. I. Gif-sur-Yvette, France, Centre d'Etudes Nucleaires de Saclay, 1966. (In French).

The ammonium salt of hexanitrodiphenylamine was irradiated by ^{60}Co γ rays either in phosphate-buffered medium at pH = 7 or in $NaHCO_3$ at pH = 8.35. The salt is bleached after irradiation.

The variation of the optical density measured at 420 mμ is proportional to the dose absorbed so long as the hypsochromic effect is not attained. (tr-auth)

8371 PARAMAGNETIC CENTERS FORMED BY γ IRRADIATION OF C_3 and C_4 ALCOHOLS AT 77°K. Chachaty, Claude (CEN de Saclay, Gif-sur-Yvette, France). pp 61-4 of Applications des Rayonnements en France. Vol I. Gif-sur-Yvette, France, Centre d'Etudes Nucleaires de Saclay, 1966. (In French).

Propanol, allyl alcohol, and the four saturated butanols were irradiated by γ rays at 77°K. With the exception of allyl alcohol and of tertiary butanol, their electron paramagnetic resonance spectra were composed of a single band centered at g = 2 superposed on spectra caused by free radicals. The disappearance of this band in the presence of an electron captor or by exposure of the alcohols to visible light after irradiation permits this band to be attributed to trapped electrons. (tr-auth)

8372 RADIOPOLYMERIZATION OF SOLID ACRYLONITRILE: EFFECT OF THE CRYSTALLIZATION CONDITIONS AND PHASE TRANSITIONS. Bensasson, R.; Dworkin, A.; Marx, R. (Faculte des Sciences, Orsay, France). pp 87-101 of Applications des Rayonnements en France. Vol. I. Gif-sur-Yvette, France, Centre d'Etudes Nucleaires de Saclay, 1966. (In French).

The specific heat of solid acrylonitrile was studied between −196 and −83°C after solidification by different methods. The influence of the conditions of crystallization and of phase transition on the polymer yield and the heat evolution after irradiation of this polymer in the solid state was examined. It was shown that the phase transitions explain the kinetic and calorimetric results. (tr-auth)

8373 GRAFTING OF STYRENE–ACRYLONITRILE MIXTURES IN POLYVINYL CHLORIDE BY THE DIRECT RADIOCHEMICAL METHOD. Chapiro, Adolphe; Jendrychowska-Bonamour, Anna-Maria (CNRS, Bellevue, France). pp 65-76 of Applications des Rayonnements en France. Vol. I. Gif-sur-Yvette, France, Centre d'Etudes Nucleaires de Saclay, 1966. (In French).

The radiochemical grafting of mixtures of styrene and acrylonitrile on polyvinyl films at 20°C was studied. The reaction took place in a gel of the polymer swollen by the two monomers. The degree of swelling of the polyvinyl chloride was much larger in some mixtures than either of the two monomers alone; the swelling was at a maximum for the mixture containing 30% acrylonitrile. The curve representing the grafting rate as a function of the composition of the monomer mixture has a complex form. Studies of the radiochemical copolymerization of these two monomers showed that a part of this complexity is caused by the precipitation of the copolymer in the reaction medium for acrylonitrile concentrations higher than 95%. The differences observed between the curves of grafting and copolymerization were interpreted by perturbation introduced in the grafting reaction by the effect of the gel and by diffusion of the monomers. When the reaction conditions are such that the grafting kinetics is not controlled by the diffusion, the composition of the grafts is close to that of the statistical copolymer obtained in the same mixture of the two polymers. (tr-auth)

8374 RADIATION GRAFTING OF 4-VINYLPYRIDINE ONTO PVC FIBERS. Roudeix, H. (Center of Nuclear Research, Saclay, France). pp 77-86 of Applications des Rayonnements en France. Vol. I. Gif-sur-Yvette, France, Centre d'Etudes Nucleaires de Saclay, 1966.

The radiation grafting of 4-vinylpyridine on polyvinyl chloride fibers was studied using methanol as a monomer solvent. In fibers unswollen before irradiation the grafting reaction was almost nonexistent for monomer concentrations below 20%. In swollen fibers grafting ratios of 90% were obtained with solutions of 30, 40, and 50% monomer concentrations, but only 20% grafting was obtained with a 10% vinylpyridine solution. Studies of 40% 4-vinylpyridine solutions showed an induction period of 5 to 6 hours for the grafting of unswollen fibers. The homopolymer formation in 40% solutions was also determined. When grafting was superficial and below 15 to 20%, the fibers kept the aspect of new fibers and the flexibility and hand were not affected. They had a good aptitude for acid dyeing. With fibers grafted throughout the whole section, dyeing was not successful. The grafted fibers were insoluble in all solvents tested. Some mechanical tests indicated that the grafted copolymer behaves like an inert form, which does not participate in the strength of the fibers. (J.S.R.)

8375 RADIOCHEMICAL COPOLYMERIZATION IN THE SOLID PHASE. Chapiro, Adolphe; Jendrychowska-Bonamour, Anna-Maria; Roussel, Daniel (CNRS, Bellevue, France). pp 119-22 of Applications des Rayonnements en France. Vol. I. Gif-sur-Yvette, France, Centre d'Etudes Nucleaires de Saclay, 1966. (In French).

The copolymerization of styrene with methyl methacrylate and acrylonitrile was studied at −78°C in the solid phase by initiating the reaction with γ rays. The kinetics of these reactions and the composition of the copolymers lead to the conclusion that these copolymerizations proceed by a radical mechanism and the termination reactions are very strongly retarded. (tr-auth)

8376 RADIOCHEMICAL POLYMERIZATION OF SOME VINYLIC COMPOUNDS IN SOLID MIXTURES WITH PARAFFIN OIL. Chapiro, Adolphe; Pertessis, Maria (CNRS, Bellevue, France). pp 123-30 of Applications des Rayonnements en France. Vol. I. Gif-sur-Yvette, France, Centre d'Etudes Nucleaires de Saclay, 1966. (In French).

The radiochemical polymerization of methyl methacrylate (MMA), methyl acrylate (MA), vinyl acetate (VA), and styrene (ST) in solid mixtures with paraffin oil was studied at −78°C. In the case of MMA the reaction was very fast. The conversion curve had a long linear portion whose slope was maximum for mixtures containing 10% of the monomer. The molecular weights of the polymer obtained followed an analogous law. The reaction was inhibited by oxygen and by other free radical interceptors, which suggests that the polymerization proceeds by a radical mechanism. From the velocities and the molecular weights, the radiochemical yields of radicals that effectively initiated polymerization chains were calculated. This yield was a maximum for a concentration of 15% MMA in the solid mixture; for this concentration G(R) = 1.44. These yields were compared with values deduced from electron paramagnetic resonance measurements in the same mixtures. The three other monomers examined had kinetic characteristics analogous to those obtained for MMA, that is, the polymerization velocity was maximum for very low concentrations of the monomer in the mixture. However, the reaction was much slower in these systems. The role played by paraffin oil in these reactions is discussed in the light of these results. (tr-auth)

8377 KINETIC STUDY OF THE RADIOCHEMICAL POLYMERIZATION OF ISOPRENE. Hinschberger, Andre; Marchal, Jean (Centre de Recherches sur les Macromolecules, Strasbourg). pp 131-4 of Applications des Rayonnements en France. Vol. I. Gif-sur-Yvette, France, Centre d'Etudes Nucleaires de Saclay, 1966. (In French).

Kinetics of the radiochemical polymerization of pure degassed isoprene were studied between −196 and 40°C. They are explained by the superposition of two independent polymerization mechanisms. The first, at the monomolecular termination, is probably cationic, whereas the second, at the bimolecular termination, is radical. (tr-auth)

8378 THE STRUCTURE OF SOLID MIXTURES OF PARAFFIN OIL WITH VINYL MONOMERS. INTERPRETATION OF RADIOCHEMICAL POLYMERIZATION IN THEIR MIXTURES AT LOW TEMPERATURES. Spritzer, Charles; Sella, Claude; Chapiro, Adolphe (CNRS, Bellevue, France). pp 135-8 of Applications des Rayonnements en France. Vol. I. Gif-sur-Yvette, France, Centre d'Etudes Nucleaires de Saclay, 1966. (In French).

Examination of mixtures of methyl methacrylate or of styrene with paraffin oil showed that at low temperature the monomers crystallize in the pure state at temperatures much below their respective melting points. A phase separation is produced during cooling and the monomer phase undergoes a very important supercooling because of its dispersion in fine droplets in the vitreous mass of the paraffin oil. Polymerization is effected in these isolated liquid droplets under conditions that recall those occurring in emulsion polymerizations. (tr-auth)

8379 PHOTOLYSIS OF THE FREE RADICALS PRODUCED BY THE γ IRRADIATION OF SOME C_3 AND C_4 ALCOHOLS AT 77°K. Chachaty, Claude (CEN de Saclay, Gif-sur-Yvette, France). pp 19-22 of Applications des Rayonnements en France. Vol. I. Gif-sur-Yvette, France, Centre d'Etudes Nucleaires de Saclay, 1966. (In French).

The photolysis at 2,537 Å of the free radicals formed by γ irradiation at 77°K was studied by electron paramagnetic resonance in some C_3 and C_4 alcohols. The alkyl radicals resulting from this photolysis react with the molecules of the substrate by capturing H atoms fixed on C atoms or by taking hydroxyl groups. (tr-auth)

8380 RADIATION CHEMISTRY OF POLYMERS. Chapiro, Adolphe (CNRS, Bellevue, France). pp 23-35 of Applications des Rayonnements en France. Vol. I. Gif-sur-Yvette, France, Centre d'Etudes Nucleaires de Saclay, 1966.

The basic mechanisms in the radiation chemistry of solid polymers and of polymers in solution are reviewed. The chemical changes and the reaction mechanisms are discussed. Typical examples are given. (J.S.R.)

8381 KINETIC STUDY OF THE RADIOLYSIS OF DILUTE AQUEOUS BROMIDE SOLUTIONS IN THE PRESENCE OF HYDROGEN. Ferradini, C.; Koulkes-Pugo, A. M. (Laboratoire Curie,

Paris). pp 37-41 of Applications des Rayonnements en France. Vol. 1. Gif-sur-Yvette, France, Centre d'Etudes Nucleaires de Saclay, 1966. (In French).

Water exposed to the action of ^{60}Co γ radiation in the absence of air is not decomposed appreciably because of inverse reactions between H and OH radicals and the products H_2O_2 and H_2. However, these reactions can be easily inhibited by the presence of Cl^- or Br^- ions, which permit accumulation of H_2O_2 and H_2. The initial yield of H_2O_2 was measured as a function of the ratio Br^-/H_2 to determine the ratio of the velocity constants of $H_2 + OH \rightarrow H + H_2O$ and $Br^- + OH \rightarrow Br + OH^-$. The H_2 pressure was kept constant during the irradiation between 1 and 20 atm. The solutions were 0.8N in H_2SO_4 or at pH = 2.2. No pH effect was found on the ratio of the velocity constant. If the value 4.4×10^7 lm^{-1} sec^{-1} determined by Schwarz for the $H_2 + OH$ reaction is adopted, a value of $Br^- + OH = 3.6 \times 10^{10}$ lm^{-1} sec^{-1} is found, very similar to that considered by Burton and Kurien for Br^- ions with the parents of molecular hydrogen peroxide. A kinetic interpretation of the results is suggested. (tr-auth)

8382 DETERMINATION OF THE RATIO OF THE VELOCITY CONSTANTS OF NITROGEN PROTOXIDE AND OF NITRATE IONS WITH SOLVATED ELECTRONS PRODUCED BY γ RADIOLYSIS OF NEUTRAL, AQUEOUS SOLUTIONS. Koulkes-Pujo, Anne-Marie; Mahlman, Harvey A. (Laboratoire Curie, Paris). pp 45-7 of Applications des Rayonnements en France. Vol. I. Gif-sur-Yvette, France, Centre d'Etudes Nucleaires de Saclay, 1966. (In French).

The ratio of the velocity constants of nitrogen protoxide and of nitrate ions with solvated electrons, determined by measurement of the N_2 yield formed by radiolysis of mixtures of these components in aqueous solutions, seemed to show that potassium nitrate is 2.7 times better at electron capture than nitrogen protoxide. The electron yield determined in these conditions is 2.58. (tr-auth)

8383 STUDY OF THE RADIOLYSIS OF PYRIDINE IN THE LIQUID STATE. Antoine, Francoise (Faculte des Sciences, Orsay, France). pp 49-51 of Applications des Rayonnements en France. Vol. I. Gif-sur-Yvette, France, Centre d'Etudes Nucleaires de Saclay, 1966. (In French).

The effect of ^{60}Co γ rays on pure pyridine at room temperature in the absence of air was studied. In order to determine the total radical yield G(-R) = 3.3, two interceptors were used. The principal radiolytic products were: a polymer ($G_{PI} = 3.8$), α,α-dipyridyl ($G_{\alpha,\alpha\text{-dipy}} = 1.1$), H($G_H = 0.025$), gaseous hydrocarbons ($G_{C_3} = 0.045$), and hydrocyanic acid ($G_{HCN} = 0.020$). (tr-auth)

8384 EFFECTS OF IONIZING RADIATIONS ON TRIBUTYL PHOSPHATE (TBP). Canva, Jennifer; Pages, Monique (Laboratoire Curie, Paris). pp 53-5 of Applications des Rayonnements en France. Vol. I. Gif-sur-Yvette, France, Centre d'Etudes Nucleaires de Saclay, 1966. (In French).

The ionic and radical mechanisms proposed to explain the radiolytic degradation of tributyl phosphate are briefly outlined. In order to test the validity of these two theories, aerated solutions of TBP containing initially 2×10^{-3} to 10^{-4} M iodide were irradiated. The results, shown graphically, support the ionic mechanism. In addition, the effect of organic additions to the TBP was studied. Aromatic compounds were found to protect TBP in the following order: toluene < benzene < biphenyl < naphthalene < phenanthrene. Possible mechanisms to explain this protective effect are discussed. (J.S.R.)

8385 APPLICATIONS DES RAYONNEMENTS EN FRANCE. VOLUME II. (Applications of Radiation in France. Volume II). [Gif-sur-Yvette, France, Centre d'Etudes Nucleaires de Saclay] 1966. 146p.

Articles published in France in 1965 on the application of radiation are compiled. The second volume includes articles on chemistry, biology, agriculture, and technological studies. Individual abstracts were prepared for five of the papers. The remaining 16 papers were previously published in NSA and appeared as 19: 15591, 17532, 40563, 40577, 40578 and 20: 2496, 5324, 8656, 10702, 10875, 14321, 14600, 14601, 18741, 23094, and 23559. (J.S.R.)

For abstracts of individual papers see: 8386—8389 and 9046.

8386 VELOCITIES OF OXIDATION OF MINERAL IONS BY OH RADICALS. II. VELOCITY OF OXIDATION OF Cr^{3+} IONS. Muller, Jean-Claude; Ferradini, Christiane (Laboratoire Curie, Paris). pp 29-33 of Applications des Rayonnements en France. Vol. II. Gif-sur-Yvette, France, Centre d'Etudes Nucleaires de Saclay, 1966. (In French).

The rate of oxidation of Cr^{3+} ions by OH radicals was compared to that of the reaction $OH + H_2 \rightarrow H + H_2O$. For this purpose solutions containing both Cr^{3+} and $Cr_2O_7^{2-}$ ions were irradiated by ^{60}Co γ rays under different H_2 pressures. The measurement of the reduction yield made it possible to determine the ratio $(\underline{k}OH + Cr^{3+})/(kOH + H_2) = 7$. Study of the effect of the H_2SO_4 concentration led to the value $(\underline{k}OH + HSO_4^-)/(\underline{k}OH + H_2) = 0.011$. The reaction rate of $OH + Cr^{3+} \rightarrow OH^- + Cr^{4+}$ was compared with the reaction of the same ions with the precursors of molecular hydrogen peroxide in order to define the nature of these precursors. (tr-auth)

8387 RECTIFICATION ON THE APPARENT EFFECT OF AN ELECTRIC FIELD ON THE RADIOPOLYMERIZATION OF SOLID ACRYLONITRILE. Chapiro, Adolphe; Inoue, Miyako (CNRS, Bellevue, France). pp 73-5 of Applications des Rayonnements en France. Vol. II. Gif-sur-Yvette, France, Centre d'Etudes Nucleaires de Saclay, 1966. (In French).

Experiments showed that modification of the kinetic characters of the polymerization of solid acrylonitrile observed previously when the irradiation cell was electrically grounded was due to an increase in the sample temperature. The presence of the electric wire under the cell introduced an air layer, which isolated the cell of the cryostat and resulted in elevation of the temperature at which acrylonitrile undergoes a structure transformation. It is this that is responsible for the modification of the characters of the polymerization. (tr-auth)

8388 KINETIC CHARACTERISTICS OF THE RADIOCHEMICAL POLYMERIZATION OF CRYSTALLIZED ACRYLAMIDE. Chapiro, Adolphe; Zumer, Maxime (CNRS, Bellevue, France). pp 77-80 of Applications des Rayonnements en France. Vol. II. Gif-sur-Yvette, France, Centre d'Etudes Nucleaires de Saclay, 1966. (In French).

The radiochemical polymerization of acrylamide at 20°C was studied in a wide range of γ intensities. Autoaccelerated conversion curves were obtained. The instantaneous velocity verified the relation $V_{inst.} = KI^{0.8}$. Experiments with monomer crystals of different qualities showed that this parameter had only a slight influence on the reaction velocity. The molecular masses of the polymers formed increased with conversion. For a given conversion they were smaller when the radiation intensity was highest. The molecular masses were much larger when the monomer crystals were fused and recrystallized by fast tempering before irradiation. The initiation radiolytic yield G(initiator centers) was calculated from the velocities and molecular masses. This yield varied from 1.0 to 2.5. It was larger when the intensity was small. (tr-auth)

8389 CONTRIBUTION TO THE STUDY OF THE RADIOLYSIS OF POLYISOBUTYLENE. Danon, Jeanne (Faculte des Sciences, Orsay, France). pp 5-10 of Applications des Rayonnements en France. Vol. II. Gif-sur-Yvette, France, Centre d'Etudes Nucleaires de Saclay, 1966. (In French).

The effect of γ radiation on the viscosity index was studied as a function of the mean molecular weight in order to determine the value of the degradation yield of polyisobutylene from absolute measurements of the molecular weights of irradiated samples and to examine the problem of the role of reticulation in the radiolysis. The results obtained are presented graphically and in tables. These showed that oxygen has no appreciable effect on the radiolysis of polyisobutylene. In addition to degradation polyisobutylene undergoes some reticulation. The significance of these results is discussed. (J.S.R.)

8390 A STUDY OF THE GAS-PHASE GAMMA RADIOLYSIS OF MONOMETHYLAMINE AND DEUTERATED MONOMETHYLAMINES. McAlonie, George Edward. Durham, N. H., Univ. of New Hampshire, 1966. 51p.

Thesis.

The gamma radiolysis of monomethylamine, monomethylamine-d_2, and mixtures of monomethylamine and monomethyl-d_3-amine-d_2 was studied at ambient temperatures. Products not previously reported were found by mass spectrometry to be ethane, nitrogen, trimethylamine, C_4 amine, and C_5 amine. These products are all small fractions of the major products: hydrogen, ammonia and methane. Isotopic analysis of the hydrogen product definitely indicated a two-mechanism production of molecular hydrogen. The major contributor to the primary process in hydrogen formation was elimination of hydrogen atom from the excited molecule followed by subsequent reaction of hydrogen atom with the substrate. A contribution of 10 to 15% was attributed to mononuclear elimination of molecular hydrogen. Methane formation can be accounted for by either methyl radical production or intramolecular formation of methane. (Dissertation Abstr.)

Radiochemistry

8391 PREPARATION OF WEIGHTLESS SOURCES OF PROTACTINIUM OBTAINED BY SPALLATION OF ^{232}Th. Briand, J. P.; Chevallier, P. (Institut du Radium, Paris). pp 321-3 of

Physico-Chimie du Protactinium. Paris, Centre National de la Recherche Scientifique, 1966. (In French).

A method for protactinium extraction from a thorium target irradiated by protons of 15 to 70 MeV is described. Electrodeposition on several metals as a method for preparing weightless sources for α spectrography by means of junction detectors is briefly discussed. (auth)

8392 PREPARATION OF PROTACTINIUM SOURCES FOR ALPHA SPECTROGRAPHY. Bastin-Scoffier, G.; Walen, R. J. (CNRS, Orsay, France). pp 315-20 of Physico-Chimie du Protactinium. Paris, Centre National de la Recherche Scientifique, 1966. (In French).

A method of preparation of very pure Pa sources using extractions with isopropylphenylketone is given. (auth)

8393 APPLICATION OF MOESSBAUER EFFECT IN THE INVESTIGATION OF THE FORM AND STABILIZATION OF RECOIL ATOMS FROM ^{119m}Sn AND TIN OXIDE. Nesmeyanov, A. N. Babeshkin, A. M.; Bekker, A. A.; Fano, V. Radiokhimiya, 8: 264-6(1966). (In Russian).

The reaction ^{118}Sn(n,γ)^{119m}Sn was studied and stabilization of atoms of ^{119m}Sn in tin oxide, irradiated in a heavy-water PT-2500 reaction by 2.2×10^{13} neutrons/cm^3 sec for 2 months, was analyzed. The absorption spectra were analyzed and the peaks corresponding to ^{119m}Sn atoms in Sn*O and Sn*O_2 forms were identified. The β-Sn* was also found by comparing all absorption spectra. The recoil atoms of ^{119m}Sn produced by the (n,γ) reaction exhibited energy of several hundred electron volts and on collision with surrounding atoms were capable of knocking out several atoms from the lattice causing various disturbances and forming various defects and vacancies, mainly in the atom-stabilization regions. It was shown that the kinetic and stabilized forms of hot atoms in solids are more complex than assumed by W. F. Libby. (R.V.J.)

8394 RECOIL TRITIUM REACTIONS: STUDIES ON THE SYSTEM T+SiH_4. Cetini, G.; Gambino, O.; Castiglioni, M.; Volpe, P. (Univ. of Turin). J. Chem. Phys., 46: 89-94(Jan. 1, 1967).

Reaction of monosilane with hot tritium atoms was investigated and the extent of formation of SiH_3T, HT, and higher tritiated silanes determined. A special study was made of the effects of I_2 as radical scavenger and of ^{4}He as moderator to verify the applicability of the kinetic Wolfgang theory to the system. The bond energy of Si−H was also correlated with the variation of the found ratio HT/RT, as compared with the same ratio in the system H + CH_4. (auth)

8395 SPECTROPHOTOMETRIC STUDY OF THE PHENOMENON OF RADIOLYTIC AUTOREDUCTION OF TETRAVALENT PLUTONIUM IN CONCENTRATED PERCHLORIC MEDIUM. Perez-Bustamante, J. A. (Junta de Energia Nuclear, Madrid). An. Real Soc. Espan. Fis. Quim. (Madrid), Ser. B, 62: 1159-64 (Nov. 1966).

The radiolytic autoreduction process of Pu(IV) in concentrated perchloric acid solution (6 M) containing either 3.46×10^{-3} or 1.55×10^{-2} g at. Pu/l was studied. Spectrophotometric studies showed that the characteristic maxima of Pu(IV) at 470 and 730 mμ became gradually reduced at the same time that those corresponding to the Pu(III) species located at 600 and 900 mμ increased simultaneously. The small contribution of the Pu(VI) valence state was evidenced by the comparatively insignificant optical density of the characteristic maximum at 833 mμ, which possessed a very high molar absorptivity as compared to the other Pu valence states at any wavelength inside the interval covered. It was concluded that the total Pu concentration plays a very important role with regard to the extent of the radiolytic autoreduction process. (P.C.H.)

Separation Processes

Refer also to abstracts 8256, 8291, 8300, 8324, 9216, and 10162.

8396 (AAEC-E-152) FISSION PRODUCT SEPARATION FROM BERYLLIUM BY ION EXCHANGE. Fardy, J. J. (Australian Atomic Energy Commission Research Establishment, Lucas Heights). Apr. 1966. 34p. Dep. mn.

An ion-exchange process was developed on a laboratory scale for the separation of low-level fission product activity from beryllium in aqueous nitrate solution. A 97% recovery of beryllium with gross beta and gamma decontamination factors of 10^4 and 2×10^3, respectively, was demonstrated. The process is flexible and should be applicable to both sulfate and chloride media. (auth)

8397 (LA-3541) KINETICS OF THE ANION EXCHANGE OF URANIUM(VI) ON DOWEX 1X4 FROM NITRIC ACID SOLUTIONS. James, D. B. (Los Alamos Scientific Lab., N. Mex.). June 20, 1966. Contract W-7405-eng-36. 14p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The kinetics of the sorption of uranium(VI) from nitric acid solutions on Dowex 1X4 anion-exchange resin were studied. The system is controlled by diffusion within the resin phase and described by a constant-diffusion-coefficient theory. Diffusion coefficients for 5, 7, and 8.3M nitric acid at 24°C are 7.4×10^{-8}, 5.2×10^{-8}, and 4.0×10^{-8} cm^2/sec, respectively, and for 7M nitric acid at 40 and 60°C are 1.2×10^{-7} and 3.3×10^{-7} cm^2/sec, respectively. The diffusional activation energy is 13 kcal/mole. (auth)

8398 (LFEN-NI-29) INFLUENCIA DA GRANULOMETRIA DOS MINERIOS NA LIXIVIACAO ESTATICA. (Influence of Mineral Granulation on the Extraction of Uranium). Carreira Pich, H. (Junta de Energia Nuclear. Laboratoria de Fisica e Engenharia Nucleares, Sacavem). 1966. 9p. (In Portuguese). (CONF-650456-1). Dep. mn.

From 3rd Conference on Lixiviation of Uranium Ores by Capillary Action, Sacavem, Portugal.

The effect of granulation of components of liquors from the static leaching of minerals was examined. Some results obtained with ores of Barroca Funda and of Quinta do Bispo are presented. The results show that the composition of the liquors is strongly affected by granulation in the mineral used. It was verified that the ratios Fe^{3+}/Fe^{2+} and Fe^{3+}/PO_4^{3-} increase sharply with the granulation. The ores studied contained U_3O_8 and Fe_2O_3. (J.S.R.)

8399 (RL-SEP-675) FLUORINATION REACTIVITY OF PLUTONIUM DIOXIDE PREPARED BY DIRECT CALCINATION OF PLUTONIUM NITRATE IN A SCREW CALCINER. Felt, R. E. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Dec. 1965. Contract AT(34-1)-1350. 37p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

A horizontal screw calciner for continuously calcining plutonium nitrate solution to reactive plutonium dioxide has been demonstrated. However, a calcination additive was required to produce a reactive oxide capable of complete fluorination. Sulfate as ammonium sulfate or calcium as calcium nitrate were added to the plutonium nitrate feed in the calciner. Each of these additives increased the fluorination reactivity of the oxide from 20 to >80%. Of the two, the calcium nitrate additive produced a more reactive oxide product at a lower fluorination temperature and shorter residence time. Fluorination reactivity studies were made on additive-containing direct-calcined oxide. A batch fluorinator, thermobalance, and a reduction vessel were used as analytical tools to measure the reactivity of the oxide. The effects of calcination parameters upon oxide reactivity were determined, and operating and design criteria were established. Fluoride produced from oxide containing the calcium additive gave a 97 to 100% metal yield, and metal-slag separation was superior to that obtained with fluoride produced via the oxalate precipitation process. (P.C.H.)

8400 CONCENTRATION OF RADIOACTIVE EFFLUENTS BY FORCED AIR DRAFT EVAPORATION. Pottier, P. (CEN. Cadarache, France); Chauvet, P.; de Flers, Ph.; Charuit, P. Energ. Nucl. (Paris), 8: 483-8(Nov. 1966). (In French).

A procedure, which concentrates, by natural evaporation, the liquid radioactive effluents of Nuclear Energy Study Centers, is described. This method does not produce distillates because air is a dilution agent. The absence of condensates avoids any pollution from underground water levels and rivers. (auth)

8401 LAUMONTITE: A NATURAL ION EXCHANGE MINERAL WITH HIGH SELECTIVITY FOR CESIUM. Romantschuk, Hakan; Miettinen, J. K.; Kivalo, P. (Univ. of Helsinki). Suomen Kem., 39B: 193-5(1966).

The occurrence of the zeolitic mineral laumontite ($CaAl_2Si_4O_{12}$ + $4H_2O$) in Finland prompted an investigation of the ability of this mineral to decontaminate radioactive waters. The capacity of laumontite to exchange trace amounts of the ^{90}Sr and ^{137}Cs from solutions containing high concentrations of inactive Na and Ca ions is described. Preliminary experiments showed the exchange capacity of laumontite for both Sr and Cs to be 0.086 meq/g and independent of the grain size. This figure was obtained from the breakthrough curves of laumontite columns. Laumontite (0.5 to 5 g) of grain size 0.12 to 0.25 mm was equilibrated with solutions which contained trace amounts of ^{137}Cs or ^{85}Sr. The pH was adjusted to 9 to 10 with Na or Ca hydroxide, respectively, before equilibration in polyethylene flasks, which were shaken intermittently, and after 5 to 7 days the activity remaining in the solutions was measured. Laumontite has a high selectivity for Cs at trace levels. The distribution coefficient K_d^{Cs} was 10^4 for Cs in 0.01N NaCl solution, although the total exchange capacity was only 0.086 meq Cs/g laumontite. The absorption rate was sufficiently high for laumontite to be used in columns to remove ^{137}Cs from solution. The presence of Ca strongly diminishes the sorption of Sr.

As the Sr exchange capacity of laumontite was 0.086 meq/g there was no selectivity for Sr over Ca under these conditions. The exchange of tracer Cs was, however, different. Cesium adsorption was strong even in the presence of Na and Ca. Parallel experiments with laumontite of grain size 0.49 to 2.00 mm confirmed that the tracer adsorption capacity is independent of the grain size. (BBB)

8402 SEPARATION OF RARE EARTH ELEMENTS FROM THORIUM, SCANDIUM, AND URANIUM BY n-BUTYRIC ACID EXTRACTION. Galkina, L. L. Radiokhimiya, 8: 358-60(1966). (In Russian).

The extraction of thorium, scandium, and uranium using n-butyric acid led to a more acid range than in the extraction of rare earth elements. All the indicated elements were extracted with high distribution coefficients. Thorium and uranium were separated from the rare earth elements by a single extraction with butyric acid at pH = 2.0 to 2.3 and scandium was separated by double extraction at pH = 2.15 to 2.35. (tr-auth)

8403 URANIUM CONCENTRATION FROM LARGE VOLUMES OF WATER DIRECTLY AT THE WATER SOURCE. Roslyakov, V. S.; Ezhova, M. P. Radiokhimiya, 8: 360-2(1966). (In Russian).

A field device, which makes it possible to use the effective precipitating agent activated charcoal for the rapid and almost complete concentration of uranium from water samples of different volume directly at the water source, was developed. (tr-auth)

8404 RADIOCHEMICAL ANALYSIS USING ION-EXCHANGE RESINS IN MIXED AND ANHYDROUS SOLVENTS. I. SEPARATION OF ^{137}Cs FROM MIXTURES AND SEPARATION OF THE RADIOACTIVE ISOTOPES ^{137}Cs–^{89}Sr–^{144}Ce AND ^{140}Ba–^{140}La IN ANIONITE AV-17 IN AQUEOUS ORGANIC NITRIC ACID SOLUTIONS. Zaborenko, K. B.; Bogatyrev, I. O.; Malygina, N. L. Radiokhimiya, 8: 352-7(1966). (In Russian).

The sorption of the radioactive isotopes ^{137}Cs, ^{89}Sr, ^{144}Ce, and ^{141}Ce on the weakly basic anionite AV-17 from aqueous organic solutions containing nitric acid was investigated. The dependence of the distribution coefficients on the concentration and nature of the organic solvent and concentration of the nitric acid was studied. A method for the ion exchange separation of the radioactive isotope mixtures Cs–Sr–Ce and Ba–La in aqueous organic nitric acid solution is proposed. Cs was separated from mixtures with passage through an anionite column of a 95% solution of acetone (0.5 N in HNO_3), Sr or Ba was eluted then with 85% CH_3OH (0.5 N HNO_3), and Ce or La was eluted with aqueous solutions of nitric acid. (tr-auth)

8405 PHOSPHATE PRECIPITATION AS A METHOD OF PURIFYING WEAKLY RADIOACTIVE WASTE WATERS. Shvedov, V. P.; Strizhov, S. G.; Kostikov, V. A. Radiokhimiya, 8: 369-71(1966). (In Russian).

Studies were made to ascertain the applicability of the phosphate precipitation method to the deactivation of weakly radioactive waste waters of complex chemical composition and to determine the purification coefficients thus obtained. In initial experiments on the removal of ^{90}Sr alone, the method was found to be highly effective. The degree of purification increases somewhat (by 20%) when the ratio PO_4^{3-}/Ca^{2+} increases from 1 to 5. The amount of Ca^{2+} ion in the mixture affects the purification, and at a ratio $PO_4^{3+}/Ca^{2+} = 3:1$, the optimum amount of Ca^{2+} is 300 mg/dm^3. Phosphate precipitation was then carried out on waste waters containing ^{89}Sr, ^{90}Sr, ^{90}Y, ^{91}Y, ^{45}Ca, ^{35}S, ^{133}Ba, ^{134}Cs, and ^{137}Cs, at a Ca^{2+} concentration of 300 mg/dm^3, $PO_4^{3-}/Ca^{2+} = 5$, and pH = 10.2-10.4. The results were quite satisfactory. The quantities of fission products removed from the solution were: ^{89}Sr, ^{90}Sr, 99.4 to 99.9%; ^{90}Y, ^{91}Y, 99.4 to 99.9%; ^{133}Ba, 96.7 to 99.4%; ^{45}Ca, 99.7 to 99.8%; and ^{35}S, 65%. (ATD)

8406 MATHEMATICAL DESCRIPTION OF TWO-PHASE SEPARATION PROCESSES. Arkenbout, G. J.; Los, J.; Smit, W. M. (Inst. for Physical Chemistry, Utrecht). Ber. Bunsenges. Physik. Chem., 70: 823-7(Nov. 1966).

An improved derivation of the column equation for two-phase processes is given including the axial dispersion effects. The derivation starts from a mass balance holding for the entire cross-section of the column. Into this mass balance the contribution of the interfacial mass transfer to the concentration distribution is introduced. Since the equation representing the interfacial mass transfer is simplified mathematically, application is limited to systems of closely related compounds such as isotopes. Although the adverse effect of the axial dispersion on separation results cannot yet be calculated, the theory may give good guidance when investigating the conditions for obtaining optimal separations. (auth)

8407 PREPARATION OF ISOTOPES WITH SHORT HALF-LIVES BY MEANS OF ISOTOPE GENERATORS. Torko, Janos. Magyar Kem. Lapja, 21: 459-64(Sept. 1966). (In Hungarian).

Mathematical equations characterizing the initial element–product element transformations, the separation methods employed in isotope generators, and some isotope generators available commercially are discussed. Among the latter, Y-90, Tc-99m, Sr-87m, I-132, Ga-68, and In-115m generators are discussed in some detail. Other isotopes produced by means of isotope generators include Al-28, K-42, Sc-44, Nb-95m, Rh-103m, In-113m, Ba-137m, La-140m, Pr-144, Pb-207m, and Ra(ThX)-224. (TSS)

8408 FRACTIONING OF A GRAFTED POLYISOBUTYLENE–POLYSTYRENE COPOLYMER PREPARED BY A RADIOCHEMICAL METHOD. Chapiro, Adolphe (CNRS, Bellevue, France); Cordier, Pierre; Jozefowicz, Jacqueline; Sebban-Danon, Jeanne. pp 103-18 of Applications des Rayonnements en France. Vol. I. Gif-sur-Yvette, France, Centre d'Etudes Nucleaires de Saclay, 1966. (In French).

The graft copolymer used was separated from the two corresponding homopolymers by selected extractions. Two methods were used for the fractionation: precipitation by propanol in a solution of the copolymer in cyclohexane and elution by the Baker and Williams method on a column having a linear temperature gradient and an eluent composition rating (isopropanol–cyclohexane system). The first method made it possible to obtain 10 fractions characterized by their chemical compositions, limit viscosity number, and mean molecular weight ($\overline{M}_n$ by osmometry and $\overline{M}_w$ by light scattering). The second method permitted 40 fractions to be obtained, which were characterized by their chemical composition, limited viscosity number, and mean molecular weight. Separation of the fraction obtained by fractional precipitation was complicated by the fact that in a wide γ range (ratio of the volume of precipitant to the total volume), the copolymers did not precipitate spontaneously and it was necessary to carry out centrifugation. For the last fractions, those richest in isobutylene, the separation was made spontaneously by flocculation. A similar phenomenon was observed during the fractionation by elution: in the first fractions collected, those richest in isobutylene, precipitated spontaneously on cooling whereas the later fractions, those richest in styrene, formed stable suspensions. The variation of the chemical composition as a function of the fraction order was studied. The fractions corresponding to the highest molecular weight had an almost constant chemical composition, containing 85 to 90% styrene. From a well-determined γ value, the styrene concentration decreased abruptly to 40 to 50%. For fractions having smaller molecular weights (only obtained by fractional elution) the styrene content increased again and reached 85 to 90%. The flocculation phenomenon appeared precisely when the styrene concentration began to decrease. The variation of the viscosity indices was studied as a function of the fraction order. Some anomalies appeared in this study, both for the mean molecular weights and for the apparent molecular weights. The results are discussed and their consequences with respect to the graft copolymer were deduced. (tr-auth)

8409 ELECTROLYTIC SEPARATION OF LEAD AND THORIUM. Bagdasarov, K. N.; Starodubskaya, A. A. (Rostov-on-Don State Univ., USSR). Izv. Vyssh. Ucheb. Zaved., Khim. Khim. Tekhnol., 9: 705-8(1966). (In Russian).

Electrolytic precipitation of lead on copper-coated platinum cathodes from solutions containing HCl and hydroxylamine hydrochloride was studied. Electrolytic separation of lead from thorium in HCl solutions was achieved with the ratio of Pb : Th = 1.8. (R.V.J.)

8410 KINETICS OF REEXTRACTION OF NITRATES OF CERTAIN METALS FROM ALKYLPHOSPHATE SOLUTIONS INTO WATER. PART I. THE SYSTEMS $UO_2(NO_3)_2 \cdot 2S$ (S = DBBP, BDBP, TBPO). Fedorov, V. S.; Pushlenkov, M. F. Radiokhimiya, 8: 132-6(1966). (In Russian).

The rate constants of reextraction reactions of the form $UO_2(NO_3)_2 \cdot 2S + nH_2O \rightarrow UO_{2hydr.}^{2+} + 2NO_{3hydr.}^{-} + 2S$ were studied in relation to the nature of S, which is a neutral organophosphorus ligand (dibutyl butylphthalate DBBP, butyl dibutylphosphinate BDBP, tributylphosphine oxide TBPO). The reextractions were carried out from solutions of the dissolvates $UO_2(NO_3)_2 \cdot 2S$ in the diluents carbon tetrachloride, chloroform, and mesitylene. The values of the rate constants of the reextraction reactions were found to decrease with the number of ester oxygens in the molecule of the extracting agent. It was noted that Hammett's rule applied to the rates of reactions of reextraction from organic phases consisting of 100% dissolvates. The nature of the diluent was found to affect the reextraction rate; this effect diminishes from DBBP to TBPO, i.e., as the number of ester oxygens in the molecule of the ex-

tractant increases. This result is explained by assuming that the reextraction process takes place in two stages: $UO_2(NO_3)_2 \cdot 2S \cdot mR \rightarrow UO_2(NO_3)_2 \cdot 2S + mR$ and $UO_2(NO_3)_2 \cdot 2S + nH_2O \rightarrow UO_2(NO_3)_2 \cdot 2S \cdot nH_2O \rightarrow UO_2^{2+}{}_{hydr.} + 2NO_3^-{}_{hydr.} + 2S$. (ATD)

8411 KINETICS OF REEXTRACTION OF NITRATES OF CERTAIN METALS FROM ALKYLPHOSPHATE SOLUTIONS INTO WATER. PART 2. THE SYSTEMS $La(NO_3)_3.3S$ + DILUENT. Fedorov, V. S.; Pushlenkov, M. F. Radiokhimiya, 8: 136-9(1966). (In Russian).

The rates of reextraction of $La(NO_3)_3$ were studied in order to determine the influence of a decrease in the number of ester oxygens in the molecules of the investigated extractants on the reaction rates and to determine whether the character of the influence of the "inert" diluent on the reextraction rate, established for systems with uranyl nitrate, is preserved. The reaction rates of reextraction of $La(NO_3)_3$ from organic phases consisting of solutions of $La(NO_3)_3 \cdot 3TBP$ (TBP = tributyl phosphate) in carbon tetrachloride, chloroform, and tributyl phosphate, and solutions of $La(NO_3)_3 \cdot 3TBPO$ (TBPO = tributylphosphine oxide) in chloroform and benzene were determined. The nature of the extractant and inert diluent was found to affect the reextraction rate, and do so in a manner analogous to the case of systems involving uranyl nitrate. It was noted that the effect of the nature of the diluent on the reextraction rate is independent of the nature of the distributed salt. This result confirms earlier assumptions to the effect that the reextraction process occurs in stages. (ATD)

8412 EFFECT OF THE COMPOSITION OF ORGANOPHOSPHORUS COMPOUNDS ON THE EXTRACTION OF CEROUS NITRATE. Orlov, Yu. F.; Shvedov, V. P. Radiokhimiya, 8: 139-45(1966). (In Russian).

The extraction of cerous nitrate with fifteen organophosphorus compounds of various structures was investigated. The distribution of ^{144}Ce was studied without adding a carrier under equilibrium conditions at 25°C, with benzene as the diluent. The distribution coefficients of cerium were determined by measuring the activity of both phases. It was shown that in the extraction of cerium (III) by phosphates and phosphonates, the inductive effect of the substituents is of decisive importance. In many cases, however, steric factors have a substantial influence. It was found that the relation between log K (K being the extraction constant of Ce(III)) and the frequency of vibrations of the P=O bond of the extractants is only very roughly linear. (ATD)

8413 ANION-EXCHANGE ADSORPTION OF GADOLINIUM AND EUROPIUM BY IRA-400 AMBERLITE FROM WATER–METHANOL SOLUTIONS CONTAINING NEUTRAL NITRATES. Molnar, F.; Khorvat, A.; Khalkin, V. A.; Volkov, V. A. Radiokhimiya, 8: 183-9(1966). (In Russian).

A method of separating light radioactive rare earth elements for purposes of nuclear spectroscopy from gadolinium targets bombarded with 680-MeV protons was investigated. Among the products of the nuclear reaction were isotopes with the relatively short half-life of 0.5 to 5 hr, whose rapid chromatographic separation made it necessary to work with systems in which the distribution coefficients were small. Systems of this type were investigated by studying the anion-exchange adsorption of radioactive gadolinium and europium (obtained from a tantalum target irradiated with 680-MeV protons) on the strongly basic resin IRA-400 in the nitrate form from water–methanol solutions. The effect of nitrate cations (H^+, Li^+, NH_4^+, Na^+, Be^{2+}, Ca^{2+}, Mg^{2+}), temperature, and concentration of the nitrate salt on the distribution coefficients and separation factors of Gd and Eu was determined. It was established that eluents containing methanol and neutral nitrates make it possible to perform the anion-exchange separation of Gd and Eu. Preliminary data on a method of separating light rare earths (Eu, Sm, and Pm) in a carrier-free state from macroquantities of Gd bombarded with 680-MeV protons are presented. (ATD)

8414 EXTRACTION OF PROTACTINIUM BY TRIBUTYL PHOSPHATE. III. DETERMINATION OF THE COMPOSITION AND STABILITY CONSTANTS OF PROTACTINIUM NITRATE COMPLEXES. Khlebnikov, V. P.; Dyachkova, R. A.; Spitsyn, Vikt. I. Radiokhimiya, 8: 125-31(1966). (In Russian).

In order to determine the composition and stability constants of nitrate complexes of protactinium, the dependence of the distribution coefficient was studied as a function of hydrogen ion and nitrate ion concentration during extraction of protactinium with tributyl phosphate. At a constant ionic strength of the aqueous phase $\mu = 5$ and 6 in the range of high acid concentrations (3 to 6 M), the distribution coefficient was shown to be proportional to the square of the hydrogen ion concentration. At the constant value $\mu = 5$, the distribution coefficient increased with the NO_3^- concentration. A mechanism is proposed for the extraction of protactinium with tributyl phosphate. The stability constants of the nitrate complexes $Pa(OH)_2(NO_3)^{2+}$, $Pa(OH)_2(NO_3)_2^+$, $Pa(OH)_2(NO_3)_3$, and $Pa(OH)_2(NO_3)_4^-$ were calculated to be respectively $\beta_1 = 17$, $\beta_2 = 1.3 \times 10^2$, $\beta_3 = 5.4 \times 10^2$, and $\beta_4 = 1.4 \times 10^3$. The equilibrium constant for the reaction of extraction of protactinium with tributyl phosphate was found to be $K = 5.4 \times 10^3$. (ATD)

8415 EXTRACTION OF CHELATE COMPLEXES OF SOME ACTINIDE ELEMENTS. Abdel Gawad, S.; Rudenko, N. P.; Lapitskii, A. V. (Atomic Energy Establishment, Inchass, Egypt). Z. Anorg. Allg. Chem., 347: 327-32(Nov. 1966).

An attempt was made to summarize some of the data obtained on the extraction behavior of thorium, protactinium, uranium, and neptunium complexes with certain substituted hydroxylamine derivatives from both acid and alkaline media. Conditions for the extraction of each element have been defined. A correlation of properties between the behavior of the different complexes of the elements concerned has been also made. (auth)

8416 SEPARATION OF A GRAM OF ^{233}Pa AND MEASUREMENT OF ITS TOTAL CROSS SECTION AS A FUNCTION OF NEUTRON ENERGY. Codding, J. W.; Berreth, J. R.; Schuman, R. P.; Burgus, W. H.; Deal, R. A.; Simpson, F. B. (Phillips Petroleum Co., Idaho Falls, Idaho). pp 325-31 of Physico-Chimie du Protactinium. Paris, Centre National de la Recherche Scientifique, 1966.

The development of a chemical separation scheme for preparing a gram of ^{233}Pa from irradiated Th is described. The development work was based largely on the use of ^{231}Pa as a stand-in for ^{233}Pa. Difficulties encountered in applying the process to the actual separation of gram-size quantities (1 g = 20,000 Ci) of ^{233}Pa are related. These difficulties resulted in changing the separations scheme from one based on solvent extraction to one based on precipitation chemistry. The final process consisted of three successive coprecipitations of ^{233}Pa with MnO_2 followed by removal of Mn and other impurities by treatment with dilute $HNO_3-H_2O_2$. This dissolved the Mn and most other impurities leaving Pa undissolved as a hydrated oxide, which was filtered off. This oxide was then dissolved in H_2SO_4 and the ^{233}Pa further purified by precipitation of the iodate. After filtration, the latter was heated to convert it to finely powdered Pa_2O_5, which was then weighed, mixed with Al powder and compacted for measurement of the total ^{233}Pa cross section as a function of neutron energy. The cross section data are presented. (auth)

8417 DISTRIBUTION OF PENTA- AND TETRAVALENT PROTACTINIUM BETWEEN DIFFERENT AQUEOUS SOLUTIONS AND AMINES ON ION EXCHANGE RESINS. Muxart, Roland; Guillaumont, Robert; Arapaki-Strapelias, Helene (Institut du Radium, Arcueil, France). pp 225-38 of Physico-Chimie du Protactinium. Paris, Centre National de la Recherche Scientifique, 1966. (In French).

The distribution of Pa(IV) and PA(V) between primary and tertiary amines (both aliphatic and aromatic) and hydrochloric and sulfuric solutions was studied. The distribution of Pa(IV) and Pa(V) between ion exchange resins and hydrochloric and sulfuric solutions was investigated. Pa(V) in hydrochloric solution was extracted by primary amines but to a small extent only (monooctylamine and monobenzylamine) if the acid concentration was at least 9M. Extraction by tertiary amines (trioctylamine and tribenzylamine) was quantitative at these acidities. Pa(IV) was not extracted by primary amines but its behavior towards tertiary amines was similar to that of Pa(V). Pa(V) in sulfuric solution was extracted by the amines at acid concentration less than 1M; the distribution coefficient depended on the nature of the solvent. The distribution coefficient of Pa(V) was measured for HCl and HCl + $HClO_4$ solutions of constant ionic strength and cation and anion exchangers on a function of Cl^- concentration. The distribution coefficient of Pa(IV) and Pa(V) for HCl and H_2SO_4 solutions and organic solutions of amines on a function of amine concentration was measured. On the basis of these data some hypotheses were formulated on the nature and the charge of the Pa(V) and Pa(IV) complexes in the aqueous phases. (auth)

8418 ION EXCHANGE OF PROTACTINIUM(V) IN HF SOLUTIONS AND SOME APPLICATIONS. Chetham-Strode, A. Jr.; Keller, O. L. Jr. (Oak Ridge National Lab., Tenn.). pp 189-93 of Physico-Chimie du Protactinium. Paris, Centre National de la Recherche Scientifique, 1966.

Distribution coefficients for protactinium on a strong-base anion exchange resin (Dowex 1 × 10) were measured over the range 2 to 27M in HF. No adsorption of Pa(V) on cation exchange resin was observed. Applications of anion exchange in HF to the separation of Pa(V) from its radioactive daughters and from Nb(V), the recovery of Pa from preparative solutions, and the analysis of Pa compounds are described. (auth)

8419 VOLATILIZATION OF PROTACTINIUM PENTACHLORIDE IN A TUBE WITH A THERMAL GRADIENT. APPLICATION TO THE SEPARATION OF THORIUM–PROTACTINIUM. Merinis, J.; Legoux, Y.; Bouissieres, G. (Institut du Radium, Orsay, France). pp 307-14 of Physico-Chimie du Protactinium. Paris, Centre National de la Recherche Scientifique, 1966. (In French).

The migration of protactinium pentachloride in a chlorine–carbon tetrachloride dynamic atmosphere, in a tube with a thermal gradient was studied. According to experimental conditions, the temperature of the compound deposition approached 100 or 300°C. These results were applied to separations of ^{232}Th from ^{233}Pa and ^{232}Th and ^{234}Th from ^{234}Pa. (auth)

8420 SEPARATION OF ACTINIUM FROM PROTACTINIUM AND THORIUM BY AMALGAMATION. David, F.; Bouissieres, G. (Institut du Radium, Orsay, France). pp 301-6 of Physico-Chimie du Protactinium. Paris, Centre National de la Recherche Scientifique, 1966. (In French).

When a lithium citrate solution of actinium, thorium, and protactinium was electrolyzed with a mercury cathode, actinium formed an amalgam whereas thorium and protactinium remained in aqueous solution. The amalgamation of actinium was rather quantitative and the factor of decontamination in thorium and protactinium was over 10^8. These results may constitute a basis for a quick separation of ^{227}Ac grown in ^{231}Pa sources. (auth)

8421 SEPARATION OF PROTACTINIUM FROM VARIOUS ELEMENTS USING BENZENEARSONIC ACID. Myassoedov, B.; Palchine, E.; Palei, P. (Inst. of Geochemistry and Analytical Chemistry, Moscow). pp 293-300 of Physico-Chimie du Protactinium. Paris, Centre National de la Recherche Scientifique, 1966. (In French).

Extraction of protactinium phenylarsenate by isoamyl alcohol from sulfuric, hydrochloric, and nitric acid solutions was investigated. Extraction by a 1% phenylarsonic acid (PAA) solution in isoamyl alcohol was quantitative when the acidity of the aqueous phases lay between 0.1 and 9N. Macroconcentrations of Al, Fe, Bi, Sb, Sn, Ti, Zr, Th, and U, and of tartaric, oxalic, and citric acids had no influence on the Pa extraction from 5N H_2SO_4. The effect of Pa and PAA concentrations, as well as of the use of other solvents, was investigated. Under the optimum conditions for Pa separation (5N H_2SO_4; 1% PAA in isoamyl alcohol) U, Th, La, and Fe remained in the aqueous phase, whereas Zr and Nb were extracted to some extent depending on their concentrations. Adsorption of Pa by activated charcoal was increased and made more selective if charcoal was saturated with PAA. More than 99.5% of Pa (D ~ 40,000) was adsorbed by PAA saturated charcoal from 1 to 8N HNO_3, HCl or H_2SO_4 solutions, when the quantity of charcoal employed was 0.5% of the total weight of the solution. The conditions for the separation of Pa from important amounts of Fe, U, Al, Mg, Mn, Zr, and Nb were established. These methods were utilized for the concentration of Pa on the milligram scale, for its separation from Nb, Zr, and Fe, and for the final purification steps of protactinium. (auth)

8422 HYDROLITIC SEPARATIONS OF PROTACTINIUM. Kirby, H. W. (Monsanto Research Corp., Miamisburg, Ohio). pp 283-91 of Physico-Chimie du Protactinium. Paris, Centre National de la Recherche Scientifique, 1966.

Milligram amounts of ^{231}Pa can be separated from its decay products, ^{227}Ac, ^{227}Th, and ^{223}Ra by hydrolysis from 1 and 6N hydrochloric acid. Separation from milligrams of thorium was accomplished by hydrolysis in 1N nitric acid and from niobium by hydrolysis in a mixture of oxalic and hydrochloric acids. Iron was separated by selective dissolution of its hydroxide in dilute hydrochloric acid. Micrograms of protactinium were separated from its decay products by adsorption on glass wool from a dilute sulfuric acid solution and by the method of residue adsorption and selective desorption from a gold surface. The application of the adsorption technique to the problem of "inextractable polymers" is discussed briefly. (auth)

8423 PURIFICATION OF PROTACTINIUM FROM NATURAL SOURCES. Kirby, H. W.; Figgins, P. E. (Monsanto Research Corp., Miamisburg, Ohio). pp 275-81 of Physico-Chimie du Protactinium. Paris, Centre National de la Recherche Scientifique, 1966.

Purification of protactinium was based on the assumption, subsequently found valid, that a procedure that quantitatively separated niobium would effectively eliminate most, if not all, other impurities. Protactinium was separated from ten times as much niobium by selective precipitation from oxalic–hydrochloric acid mixtures. Data are presented, which show that the stability of the niobium oxalate complex is 100 times as great as that of protactinium oxalate. The addition of hydrochloric acid, by repressing the ionization of oxalic acid, greatly reduced the solubility of protactinium while having relatively little effect on that of niobium. The final product, obtained by dissolution and recrystallization of protactinium from concentrated sulfuric acid, contained 0.5 microgram of niobium per milligram of protactinium. A solution containing 90 mg/ml of protactinium in approximately 5N sulfuric acid showed no hydrolysis or gel formation after more than four years. (auth)

8424 EXTRACTION OF PROTACTINIUM BY MEANS OF DERIVATIVES OF HYDROXYLAMINE. Lapitskii, A. V.; Rudenko, N. P.; Saed, Abdel Gavad (Moscow State Univ.). pp 249-53 of Physico-Chimie du Protactinium. Paris, Centre National de la Recherche Scientifique, 1966. (In French).

The conditions for solvent extraction of protactinium with derivatives of hydroxylamine (benzoylhydroxylamine, N-benzoylphenylhydroxylamine, and N-nitrosonaphthylhydroxylamine) were studied. N-benzoylphenylhydroxylamine gave the largest extracted quantity of protactinium. An attempt to explain theoretically the extraction of protactinium with N-benzoylphenylhydroxylamine was made. The possibility of obtaining carrier-free protactinium from neutron-irradiated thorium using this reagent is shown. (auth)

8425 EXTRACTION OF PROTACTINIUM BY TRIDODECYLAMINE. Guillot, Philippe (CEN, Fontenay-aux-Roses, France). pp 239-48 of Physico-Chimie du Protactinium. Paris, Centre National de la Recherche Scientifique, 1966. (In French).

The solvent extraction of protactinium, by trilaurylamine in xylene, was studied from hydrofluoric, hydrochloric, and nitric acid aqueous solutions. The maximum of extraction was at [HF] = 0.35N and [HNO_3] = 6N. In hydrochloric solutions, Kd increased with the acidity of aqueous solution. For a constant amine concentration, the distribution coefficient increased in the order: HNO_3 6N < HF 0.35N < HCl 12N. (auth)

8426 SEPARATION OF SCANDIUM AND RARE EARTHS BY ANION EXCHANGE IN ACETIC ACID–HCl MIXTURES. Kuroda, Rokuro; Hikawa, Ikuko (Univ. of Chiba, Japan). J. Chromatog., 25: 408-13(Dec. 1966).

The anion exchange behavior of scandium, the rare earths, and thorium has been investigated in mixtures of acetic acid and hydrochloric acids. These elements do not adsorb to any great extent on a strong base type anion exchange resin from hydrochloric acid, but their adsorption characteristics are greatly improved by introducing acetic acid into the system. The elements concerned thus become moderately adsorbed on the resin from a medium consisting of 90% glacial acetic acid and 10% 3N hydrochloric acid. Differences in the distribution coefficients are large enough to permit a sharp separation of scandium and the rare earths (or yttrium) in this medium. The rare earths (or yttrium) are eluted first, and then scandium can easily be removed from the column by elution with dilute hydrochloric acid. (auth)

8427 ION-EXCHANGE PROCEDURES. IX. CATION EXCHANGE IN HBr SOLUTIONS. Nelson, Frederick; Michelson, Donna C. (Oak Ridge National Lab., Tenn.). J. Chromatog., 25: 414-41(Dec. 1966). (ORNL-P-2325).

Results of a systematic study of the cation exchange behavior of elements in HBr solutions are given for a Dowex 50 resin. Many elements show adsorption minima at moderate HBr concentrations followed by a rapid increase in adsorbability at high HBr concentrations. Marked differences in adsorbabilities of the elements occur, particularly in dilute and concentrated HBr solutions. Implications of the data for separations are discussed and typical separations illustrated. (auth)

8428 ELIMINATION OF FLUORIDES FROM ACID SOLUTIONS RESULTING FROM LIXIVIATION OF SLAGS OF CALCIOTHERMIC ORIGIN AND FROM IMPURE URANIUM TETRAFLUORIDE. Sancho Rof, J.; Estrada Aguilar, J. An. Real Soc. Espan. Fis. Quim. (Madrid), Ser. B, 62: 1211-22(Nov. 1966). (In Spanish).

Methods have been studied for the preparation of uranium concentrates from slags of calciothermic origin and from impure uranium tetrafluoride. The main difficulty proved to be the elimination of fluorides from the acidic solutions used in the attack. The presence of these ions precludes the feeding of the concentrates to the purification plants if a serious risk of corrosion is to be avoided. Leaching was studied under different conditions in an attempt to prepare a concentrate with a fluoride content that would not produce problems of corrosion in the purification plants. The intended goals were not achieved but it was concluded that incomplete elimination of fluorides was due to the presence of very stable complexes of uranyl fluoride. In order to eliminate the fluorides without loss of uranyl ions it was decided to break the complexes. To accomplish this, use was made of the high reactivity of fluoride towards silica and the fluosilicic acid formed was steamed at 135°C. Very satis-

factory results were obtained and a solution free of fluorides was finally prepared. (auth)

8429 REMOVAL OF CESIUM FROM AQUEOUS SOLUTIONS BY ION EXCHANGE. Prout, William E.; Russell, Edwin R.; Groh, Harold J. Jr. (to U. S. Atomic Energy Commission). U. S. Patent 3,296,123. Jan. 3, 1967.

A process was developed for removing cesium values from aqueous solutions. Solutions containing the cesium values were contacted with an inorganic ion exchange material consisting essentially of stable granules of crystalline potassium cobalt ferrocyanide and the cesium values are preferentially taken up by the ion exchange material. The stable crystalline potassium cobalt ferrocyanide ion exchange material is prepared by adding an aqueous solution of potassium ferrocyanide to an aqueous solution containing a stoichiometric excess of a cobalt salt, such as cobalt nitrate, cobalt sulfate, or cobalt to form a potassium cobalt ferrocyanide precipitate. The precipitation is conducted at a temperature below about 30°C. The precipitate is separated from the solution and dried at a temperature not to exceed about 150°C to form a crystalline potassium cobalt ferrocyanide ion exchange material. (AEC)

EARTH SCIENCES

Geology

Refer also to abstracts 8228, 8479, and 9279.

8430 (JINR–P3-2961) OPREDELENIE GEOLOGICHESKOGO VOZRASTA SLYUD: MUSKOVITA, FLOGOPITA I BIOTITA PO SLEDAM OSKOLKOV DELENIYA YADER URANA. (Determination of the Geological Age of Mica by the Tracks of U Fission Fragments). Abdullaev, Kh.; Gorbachev, S. K.; Perelygin, V. P.; Tret'yakova, S. P. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Reactions). 1966. 10p. (In Russian). Dep. mn.

Lawson detectors were used to determine the age of muscovite phlogopite, and biotite samples taken from various deposits. Descriptions are given of the detector performance for measuring uranium concentrations in various media by recording ^{235}U fission fragments in thermal neutron fluxes. (R.V.J.)

8431 (ORO–3235-10) DATING METHODS BASED ON THE EXTINCT RADIONUCLIDES ^{129}I AND ^{244}Pu. Kuroda, P. K. (Arkansas Univ., Fayetteville. Dept. of Chemistry). [1967]. Contract AT(40-1)-3235. 18p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The meteorites and the Earth contain various amounts of excess fissiogenic xenon isotopes and there seems to be a simple relationship between the amounts of fissiogenic xenon and the present-day abundances of uranium. The spontaneous fission of the extinct radionuclide ^{244}Pu appears to have contributed to the inventories of the fissiogenic xenon in the meteorites and in the Earth's atmosphere. Most achondrites contain about 5×10^{-5} ccSTP $^{136f}Xe/g$ U, while the amounts in chondrites seem to be larger than this by a factor of 2 or 3. The meteorites also contain various amounts of excess radiogenic ^{129}Xe, which is the decay product of the extinct radionuclide ^{129}I. All the experimental data secured so far in this laboratory seem to favor the view that the ^{129}I responsible for the ^{129}Xe anomaly in the meteorites comes from the nuclear reactions; $^{128}Te(n,\gamma)^{129}Te \xrightarrow{\beta^-} {}^{129}I$ and $^{235}U(n,f)^{129}I$, the relative contributions from the above reactions depending on the Te/U ratio in the meteorites. (auth)

8432 RELATIONSHIP BETWEEN THE CONTENT OF LABILE RADIOACTIVE ELEMENTS AND THEIR CONDITIONS IN SOME IGNEOUS ROCKS. Yagi, Shinjiro; Asayama, Tetsuji (Univ. of Osaka Prefecture). Bull. Univ. Osaka Prefect., Ser. A, 14: No. 1, 93-107(Sept. 1965).

The general geology and petrology of the Kumano acid rocks area, Mie and Wakayama Prefectures are described. A summary of petrographical features and the results of chemical analyses of 16 samples of these rocks are given. In order to obtain more information on the labile radioactive elements in igneous rocks, the variation of radioactivity and the solubility of main constituent elements in some igneous rocks by dilute acid treatment is given. The results on Kumano acid rocks and also Hiratsu granitic rocks, Shiga Prefecture are presented. Low activity of pulverized rock samples of both rock types is measured effectively by a low-background gas-flow 2π counter, using an anti-coincidence electrical circuit. The variation of relative solubility of rock-forming elements by acid-leaching and that of the intensity of radioactivity of rock samples is obtained. Notable differences are recognized in both rock types as to the dissolution of radioactive elements, that is, the loss in net beta-activity is generally small (ranging from 0 to 24 percent) in Kumano acid rocks and very great (ranging from 42 to 100 percent) in Hiratsu granitic rocks. These relations are discussed from the geochemical and radiochemical points of view. It is explained that the labile radioactive elements make up a greater portion of the total radioactive elements in Hiratsu granitic rocks than of those in Kumano acid rocks. Based on all the results, it is observed that a greater portion of radioactive elements in these granitic rocks is easily leachable and exists in intergranular surfaces of constituent minerals or interstitial spaces among them. (NSA of Japan)

8433 FISSION-TRACK AGES OF INDIAN MICAS. Kere, S. S. (Indian Inst. of Tech., New Delhi). Curr. Sci. (India), 35: 509-10(Oct. 20, 1966).

A muscovite and a biotite from Gundur, India, were exposed in a reactor to a dose of 10^{17} neutrons and the $^{235}U/^{238}U$ isotopic ratio was used for age determination. Ages can be determined by this method only for the time since mica has cooled because tracks anneal out at temperatures over 200°C. Results indicate that cooling took about billion yr, and the age since cooling is ~500 million yr. (F.S.)

8434 Rb–Sr DATING OF MIDDLE PRECAMBRIAN METASEDIMENTARY ROCKS OF MINNESOTA. Peterman, Zell E. (Geological Survey, Denver). Geol. Soc. Amer. Bull., 77: 1031-44(Oct. 1966).

Whole-rock samples of middle Precambrian argillaceous metasedimentary rocks of central and northern Minnesota were dated by the $^{87}Rb/^{86}Sr$ method. Applicability of the Rb–Sr method to the dating of shales is based on the increase in the $^{87}Rb/^{86}Sr$ ratio during sedimentation. Continental crust has a mean $^{87}Rb/^{86}Sr$ ratio of about 0.25, whereas shale averages 0.50. The general problem of inherited radiogenic Sr in shales is discussed. The Rb/Sr dating of middle Precambrian metasedimentary rocks of central and northern Minnesota indicated a loss of radiogenic Sr during regional metamorphism. Samples of the Mahnomen Formation yielded 2 distinct isochrons of 1.75 and 1.46 billion yr. Samples dated at 1.46 billion yr have undergone intensive alteration by migrating solutions, probably at the time the associated iron formations were locally enriched to Fe deposits. The 1.75 billion yr isochron defined by unaltered samples probably dates the metamorphism associated with the Penokean orogeny. Lower grade metasedimentary rocks of the Virginia, Rove, and Thomson Formations yielded an isochron age of 1.57 billion yr; these units were probably open systems during the waning phases of regional metamorphism. Comparison of initial $^{87}Sr/^{86}Sr$ ratios suggested a northern source area for the Virginia and Thomson Formations and a southern one for the Mahnomen Formation. The data for altered facies of the Mahnomen Formation indicate complete loss of radiogenic strontium at 1.46 billion yr, with possible movement of Rb and common Sr. (BBB)

8435 ISOTOPIC COMPOSITION OF LEAD IN GALENA FROM SOME DEPOSITS OF MIDDLE ASIA. Rabinovich, A. V.; Golubchina, M. N.; Murtazina, T. M. (All-Union Geological Inst., Leningrad). Geochem. Int., 1: 275-8(1964).

The geochemistry of lead isotopes is important because it helps to solve such geologic problems as the relation between mineralization and magmatism, relation of magmatic complexes to the stages in the development of mobile belts in the earth's crust, correlation of intrusive and extrusive complexes, and the search for ore deposits. To establish criteria for the relation between mineralization and magmatism, the isotopic composition of lead was determined in rocks and ores from several deposits of Middle Asia, Eastern Transbaikaliya, Kazakhstan, and other regions. Isotopic analysis of Pb from galena from several Central Asian localities showed no significant differences related to the type of geologic occurrence. Leads from deposits believed to be of Upper Paleozoic age fell into 2 distinct groups, with the following isotopic ratios: $^{206}Pb/^{204}Pb$, 18.11 to 18.35 and 18.50 to 18.77; $^{207}Pb/^{204}Pb$, 15.48 to 15.84 and 15.54 to 15.80; and $^{208}Pb/^{204}Pb$, 38.60 to 39.48 and 38.93 to 39.80, respectively. The groups differed principally in the ratio $^{206}Pb:{}^{204}Pb$, which in the second group was close to that of leads from known Mesozoic deposits. If some of the deposits previously regarded as Upper Paleozoic are in fact related to Mesozoic magmatism, current theories of ore search should be revised. (BBB)

8436 MECHANISM OF ORIGIN OF RADIOMETRIC ANOMALIES OVER OIL DEPOSITS. Alekseev, F. A.; Gottikh, R. P. Int. Geol. Rev., 8: 1157-71(Oct. 1966).

Results of radiometric exploration for oil and gas in the USSR have shown that the presence of oil deposits is related to the natural γ field at the earth's surface. This is a common phenomenon, as demonstrated in oil fields of the Lower Volga region, West Turkmenia, and Azerbaijan. Intensities and anomalies of natural γ-radiation fields are related to structures in geologic sections. Positive and negative anomalies in the overburden of petroliferous as well as of sterile structures are essentially functions of lithologic and/or mineral composition of the rocks which, in turn, depend on tectonic structure of the area. Distribution of the radioactive elements in rocks of the oil and gas provinces is determined by the composition of these rocks. The rule common of all sedimentary rocks prevails within each sedimentary complex: the content of ^{40}K, Ra, U, and Th rises in going from sandstones to claystones, and gradually drops off going toward limestones. Accumulation of organic matter in the course of sedimentation leads to a considerable enrichment of the rock in U. Distribution of the radioactive elements in waters of productive oil and gas horizons, also in the aquifers, going upward, shows no effect of oil (oil deposits and migrant hydrocarbons). The higher Ra content locally observed in the water near the oil contact is accounted for by a higher metamorphism of the bottom- and edge-waters. The emergence of radiometric anomalies in surface deposits of the produc-

tive and barren structures is related to the lithology of these deposits, which in turn is determined by the tectonics of the area. When oil and gas fields are associated largely with consedimentation type tectonic uplifts, these fields reflect an anomalous behavior of the γ field. (BBB)

8437 CHANGE IN THE PRIMARY CONTENT OF ^{87}Sr IN GRANITOIDS WITH GEOLOGIC TIME. Artemov, Yu. M.; Gorokhov, I. M. (Lab. of Precambrian Geology, Leningrad). Geochem. Int., 1: 463-4(1964).

Strontium-87 is a product of the β decay of ^{87}Rb present in the earth's crust and, therefore, the isotopic composition of Sr continually changes in the direction of enrichment of ^{87}Sr. This fact may be utilized in the absolute dating of minerals that do not contain Rb. The enrichment of ordinary Sr in ^{87}Sr has not been checked experimentally, which may be ascribed to the difficulties involved in measuring slight variations in the isotopic abundance of ^{87}Sr. The difficulties are particularly great with granitic rocks because these rocks contain considerable amounts of Rb and radiogenic ^{87}Sr that accumulated after they came into existence as geologic units. Thus in calculating the abundance of ^{87}Sr in primary Sr it is necessary to introduce a large correction calculated from the age of the rock determined by another method, the contents of Rb and Sr, and the present ^{87}Sr ratio in the sample. Using extensive material, earlier authors made such calculations and found no change in the ^{87}Sr content in the primary strontium of igneous rocks with time. However, by using another method, in which the calculated primary $^{87}Sr/^{86}Sr$ ratio is independent of the decay constant of ^{87}Rb, it was shown, on the basis of 4 groups of samples analyzed for Sr isotopes, that during the last 2.7 billion years the primary $^{87}Sr/^{86}Sr$ ratio increased by ~1.5%. This value was used to calculate a Rb/Sr ratio of 0.096 in the primary magma of the granitic rocks studied; the result is so much higher than that found in basaltic magma by earlier workers that it is suggested that the two types of magma are derived from different parental materials. (BBB)

8438 SULFUR ISOTOPES IN THE RAMMELSBERG ORE DEPOSIT (GERMANY). Anger, G. (Technische Hochschule, Clausthal, Ger.); Nielsen, H.; Puchelt, H.; Ricke, W. Econ. Geol., 61: 511-36(1966).

The $^{34}S/^{32}S$ ratios and $\delta\ ^{34}S$ values were determined for 278 sulfide and 90 barite specimens from the Rammelsberg ore deposits in the Harz Mountains, Germany. The syngenetic significance of the results is discussed. Within a given part of the ore bodies the $\delta\ ^{34}S$ values of galena, sphalerite, and chalcopyrite specimens were in most cases quite similar to each other. Ore forming ions of these minerals have probably been brought by or derived from magmatic hydrothermal solutions, flowing into the Goslar through a part of the Middle Devonian Ocean. Within the main ore bodies an increase of the $\delta\ ^{34}S$ values of galena, sphalerite (and chalcopyrite) from bottom to top from about +7% to about +20% was observed. This increase in ^{34}S indicates a preference for the light sulfur isotopes in the initial stage and a depletion in ^{32}S in the last stage due to a kinetic isotope effect in the source. The major part of all pyrites shows a significant spread in $\delta\ ^{34}S$ values but enrichment in ^{32}S due to the uptake of sulfur from bacterial sulfate reduction. Some pyrite must be derived from syngenetic FeS which had been transformed to FeS_2 by biogenic sulfur during early diagenesis. The barite $\delta\ ^{34}S$ values ranged very close to +23%, the δ value of marine sulfate in the Middle Devonian Ocean. The barite must therefore be derived from magmatic hydrothermal Ba^{2+} ions and from $(SO_4)^{2-}$ ions of marine origin. Values differing from this mean may be explained by the addition of some sulfur of magmatic hydrothermal origin or by bacterial reduction of sea water sulfate. These results confirm the derivation of the Rammelsberg deposit from the syngenetic sedimentation of sulfides precipitated from exhalative solutions. Sulfate from the Devonian Ocean and bacterial activity have participated in the formation of the ore bodies to a large extent. (BBB)

8439 GEOCHEMISTRY OF URANIUM IN GRANITOIDS OF THE UPPER KONDOMA MASSIF (GORNAYA SHORIYA). Osipov, D. K.; Zhuravlev, R. S.; Komarnitskii, G. M. (Inst. of Geology and Geophysics, Novosibirsk, USSR). Geochem. Int., 1: 340-5 (1964).

A systematic study of the geochemistry of U in the magmatic rocks of this region is reported. The Upper Kondoma granodiorite massif, which is well exposed by erosion, lies to the south of Gornaya Shoriya, at the junction of the Mras anticlinorium with the Uymen'-Lebed' synclinorium. Whole-rock analyses for U were compared with the U balance computed for analyzed mineral separates from the same rocks to describe the distribution of U in the Upper Kondoma massif of granitoids and associated dike rocks, and in the intruded country rocks. Uranium occurs mainly in the rock-forming minerals, in the form of a molecular dispersion rather than in solid solution. Uranium content of the granitoids of the Upper Kondoma massif is less than 40% of the average content in acidic igneous rocks. The youngest alaskitic granites, whose U contents are close to the average crustal value for acid igneous rocks, are an exception. The fact that the U content of the alaskitic granites is markedly higher than that of the granodiorites of the massif supports the thesis that these formations have different ages; otherwise, the increased U content could only be due to crystallization differentiation. The mean U contents in the main phases of the granitoids of the massif are similar to those in the country rocks, differing only by 9.5%. Taken with other geological and geochemical data, this suggests that the granitoids inherited their U from the country rocks. All the minerals of the rocks of the intrusive complex, in both the magmatic and dike facies are U carriers, but the element is associated mainly with the rock-forming minerals (especially the feldspars). The relatively high mobility of U in the rock-forming minerals (particularly the feldspars) suggests that ore-bearing solutions may become enriched with U by extracting it from these minerals, irrespective of their age. (BBB)

8440 CONTRIBUTION TO THE STUDY OF THE RETENTION OF ^{90}Sr IN SOIL. Krotoszyner, J. P.; Kirchmann, R. (Centre d'Etude de l'Energie Nucleaire, Mol, Belg.). pp 44-59 of Pedologie. Brussels, Centre d'Etude de l'Energie Nucleaire, 1961. (In French).

A study was made of the retention of Sr in three types of soil taken from the Gembloux, Mol, and Morhet regions (Belgium). Two horizons for each of the soils were chosen and the content of humus, clay, and calcium in each was determined. A granulometric analysis of these substrata was also carried out. In the first series of experiments, the soils were introduced into percolation columns and saturated with ^{85}Sr and ^{87}Sr. A $BaCl_2$ solution was then percolated through the soil column to flush the Sr retained by capillarity and to determine the exchangeable fraction of strontium. Results showed that exchange proceeded rapidly and that absorption was mainly influenced by clay and humus. In a second series of experiments, three surface horizons of soil were shaken in the presence of carrier-free ^{90}Sr. Results showed that the examined horizons displayed no differences in absorption rate or in quantity of retained ^{90}Sr. Under the conditions of these experiments, the retained amounts of ^{90}Sr varied from 89.3 to 97.8%, according to the horizon and the shaking period employed. Extensive shaking of soil with Sr solutions produced a slight reduction in retention values and was thought to result from exchange of desorbed soil ions with absorbed Sr. It was concluded that ^{90}Sr uptake by soil is rapid, nearly complete, and similar in different soil types. (BBB)

8441 SYSTEMATICS IN THE ^{208}Pb–^{232}Th, ^{207}Pb–^{235}U, AND ^{206}Pb–^{238}U SYSTEMS. Steiger, Rudolf H.; Wasserburg, G. J. (California Inst. of Tech., Pasadena). J. Geophys. Res., 71: 6065-90(Dec. 15, 1966).

In a study of cogenetic zircons it was found that the measured $^{208}Pb/^{232}Th$ and $^{207}Pb/^{235}U$ ratios formed a linear array in the corresponding coupled Pb–U–Th evolution diagram, which has an upper intersection on the concordia curve at the same time point as that determined by the $^{206}Pb/^{238}U$, $^{207}Pb/^{235}U$ array. Although the U–Pb data lie in the accessible region for nonfractionating daughter loss, the Th–Pb results lie outside the corresponding region. The zircon concentrates analyzed were shown to be multiphase assemblages with variable U and Th contents and variable Th/U ratios, even within single crystals. The zircons contain local domains of high radioactivity which appear to be highly discordant. A relationship between discordance and the average concentration of U and Th in a sample is given. The degree of discordance increases with the concentration of U and Th and with the increasing Th/U ratio, causing preferential loss of ^{208}Pb and the departure from the region accessible to a single phase without fractionation. The theoretical aspects of the ($r\lambda_{^{238}U}$, $r\lambda_{^{232}Th}$) diagram from the viewpoint of single-phase and multiphase assemblages are discussed, and it is shown that the variability of the Th/U ratio is of fundamental importance in understanding the evolution of the Th–U–Pb system. The existence of these systematics in nature may provide an additional independent dating system and a further means of studying transport from natural systems. (auth)

8442 VARIATIONS IN RADIOGENIC STRONTIUM FOUND IN VOLCANIC ROCKS. Hedge, Carl E. (Geological Survey, Denver). J. Geophys. Res., 71: 6119-26(Dec. 15, 1966).

Analyses of the Sr isotopic composition of volcanic rocks reveal variations of nearly 2% in the amounts of radiogenic ^{87}Sr that is found in these rocks at their times of eruption. Oceanic basalts exhibit a small but real range in radiogenic Sr which probably reflects regional inhomogeneities in the upper mantle. Many continental basalts are isotopically similar to oceanic basalts; however, most continental felsic volcanics are significantly enriched in radiogenic Sr. The data suggest that continental felsic volcanic

rocks have been derived within the crust or have been appreciably contaminated by crustal material. (auth)

8443 ISOTOPIC COMPOSITION OF DIAMOND CRYSTALS AND CARBONADO. Vinogradov, A. P.; Kropotova, O. I.; Orlov, Yu. L.; Grinenko, V. A. (Vernadskii Inst. of Geochemistry and Analytical Chemistry, Academy of Sciences, USSR. All-Union Inst. of Mineral Raw Material, Moscow). Geokhimiya, No. 12, 1395-7(Dec. 1966). (In Russian).

Determinations of the isotopic composition of carbon in crystals of diamonds from deposits of Yakutia and South Africa (four determinations) and of the isotopic carbon composition of four samples of typical carbonado from Brazil are given. For diamond crystals the values $\delta\ ^{13}C$ −0.5 to 0.8‰ are typical of diamonds of kimberlite pipes, the values $\delta\ ^{13}C = -2.78$ to 2.81‰ are typical of carbonado. This difference in the isotopic composition of diamond crystals and carbonado is explained by the difference of carbon sources or of formation processes. (auth)

8444 ON THE CONTENT OF ^{90}Sr AND ^{90}Y IN SOIL IN CENTRAL GERMANY. Schilling, Guenther; Richter, Dietmar (Friedrich-Schiller-Univ., Jena, Ger.). Albrecht-Thaer-Arch., 8: 107-25(1964). (In German).

Solutions of carrier-free mixtures of $^{90}SrCl_2$ and $^{90}YCl_3$ were added to soils and to model substances (ferric hydroxide, $Al(OH)_3$, quartz sand, silicic acid, kaolin, and bentonite) to study the binding of the two radionuclides to soil constituents on the basis of their extractability. The various soils and the model substances tested adsorbed ^{90}Sr and ^{90}Y to an extent whereby it was almost impossible to extract them with distilled water at neutral pH. Adsorbed ^{90}Y could only be displaced by saline solutions in the acid range, and only up to pH 5.0. It was tightly bound to the carrier as a colloid and could not be exchanged if the pH value was higher than 5. In contrast to ^{90}Y, ^{90}Sr was found to be exchangeable in all experiments performed, but was slightly more difficult to displace with cations than calcium. Oat plants absorbed ^{90}Sr and Ca in the ratio to be expected from these interchangeability differences. Wash-out experiments that were performed in soil in situ indicated that the depths to which ^{90}Sr penetrates into the soil and the extent to which it is washed out depend on the exchange capacity of the soil and on the electrolyte content of the soil solution. The results are discussed in relation to radioactive fallout contamination of soil. (BBB)

8445 USE OF UNIVERSAL COMPUTERS FOR COMPLEX ESTIMATION OF RESULTS OF PROSPECTING FOR URANIUM DEPOSITS. Luchin, I. A. At. Energ. (USSR), 21: 210-15 (Sept. 1966). (In Russian).

Digital data are given for programming complex uranium deposit data in a universal electronic computer. Statistical bases between the known deposits and geological factors were analyzed using coded indices for a homogeneous block of information on the deposit, ore occurrence, and mineralized field. (tr-auth)

8446 OXYGEN ISOTOPE FRACTIONATION IN THE SYSTEM: QUARTZ–WATER. Ingerson, E.; Wershaw, R. L. (Univ. of Texas, Austin). Geochem. Int., 2: 691(1965).

Use of the $^{18}O/^{16}O$ ratio in quartz as a geological thermometer is reported. The coefficient of oxygen isotope fractionation was determined for the reaction $\frac{1}{2}Si^{16}O_2$ (quartz) + $H_2{}^{18}O = \frac{1}{2}Si^{18}O_2$ (quartz) + $H_2{}^{16}O$ as a function of temperature in the range from 173 to 533°C. The coefficients of isotope fractionation were also calculated from data of Raman and ir spectra using a combination of statistical models of Debye and Einstein. The computed equilibrium constants were in good agreement with constants measured in the range from 400 to 533°C, but below 400°C the experimentally measured fractionation coefficients deviated more and more from the computed values. This indicates that the isotope equilibrium is not reached in experiments carried out at temperatures below 400°C. (BBB)

8447 PRECISE MEASUREMENTS OF NATURAL STRONTIUM ISOTOPE ABUNDANCE RATIOS USING DOUBLE COLLECTION METHODS OF MASS SPECTROMETRY. Hayatsu, Akio. Toronto, Univ. of Toronto, 1965.

Thesis.

Strontium isotope abundance ratio variations are caused by additions of ^{87}Sr produced by radioactive decay of ^{87}Rb. These variations are used to estimate geological ages, and also serve as isotopic tracers in geological systems. A double collection system was designed and tested with a Metropolitan-Vickers MS-2 mass spectrometer, first for lead isotopes using electron multiplier detectors and then for Sr isotopes without multipliers. Although the attempt for lead isotopes was not successful, the results of $^{87}Sr/^{86}Sr$ ratio measurements were satisfactory, as replicate analyses on a standard sample have shown. The standard deviation of $^{87}Sr/^{86}Sr$ ratio measurements is 0.04‰, which compares favorably with the best reproducibilities obtained at other laboratories. In Sr isotope ratio measurements, the effects of isotopic fractionation occurring in mass spectrometers are eliminated by a procedure called "normalization" and hence the usefulness of the normalized ratios appears to depend on the basic assumption that $^{86}Sr/^{88}Sr$ ratio in nature is constant. A calculation was made of the effects of natural variations in $^{86}Sr/^{88}Sr$ ratios on the normalized $^{86}Sr/^{88}Sr$ ratios. The result showed that the deviation from the assumption does not invalidate the usefulness of normalization as long as our interests are in the variations in $^{87}Sr/^{86}Sr$ ratios produced by an addition of radiogenic ^{87}Sr. The technique was applied to determine a Rb–Sr age for the Bail Hill, Scotland, Andesite. Using a value of 4.7×10^{10} years for the half life of ^{87}Rb, an age of $(395 \pm 75) \times 10^6$ years was obtained. The initial $^{87}Sr/^{86}Sr$ ratio for the Bail Hill andesite was found to be 0.7043 ± 0.0008 atoms/atom. A study of Sr isotope ratio variations of a series of Grenville limestones which have been metamorphosed to varying degrees showed that the $^{87}Sr/^{86}Sr$ ratio varies from 0.707 for the least metamorphosed to 0.703 for the most metamorphosed. These results suggest that Sr isotope ratios of limestones are not always preserved during metamorphism and that considerable caution must be used in arguing the origin of carbonatites by means of Sr isotope ratios. (Dissertation Abstr.)

Meteorology

Refer also to abstracts 8549, 8573, and 8703.

8448 (AECL–2620) THE MICROMETEOROLOGY OF THE WHITESHELL NUCLEAR RESEARCH ESTABLISHMENT AT PINAWA, MANITOBA. PRE-OPERATIONAL SURVEY REPORT. Reimer, A. (Atomic Energy of Canada Ltd., Pinawa (Manitoba). Whiteshell Nuclear Research Establishment). Nov. 1966. 40p. Dep. mn. AECL $1.00.

Data obtained at Whiteshell Nuclear Research Establishment, Pinawa, Manitoba, from the micrometeorological tower and the climatological site, over a 23 month period ending in 1965, is analyzed. The 200-foot mean wind speed was found to be relatively strong (14.3 MPH) and since the 20-foot wind was reduced by the frictional effect of tree cover in the surrounding area, wind shear was large. A moderate channeling effect due to terrain features was found and during stable conditions winds were predominantly from the south half of the direction circle. Inversions usually exist at night at WNRE and strong inversions are common. Lapse rate probability and inversion duration diagrams and tables are included. (auth)

8449 (BNWL–319) REVIEW OF METHYL IODIDE BEHAVIOR IN SYSTEMS CONTAINING AIRBORNE RADIOIODINE. Mishima, J. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). June 15, 1966. Contract AT(45-1)-1830. 83p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The scientific literature describing research and other data concerned with the formation, behavior and removal of gaseous methyl iodide in a reactor containment system following a fuel melt-down accident is reviewed. The amount of methyl iodide airborne under any set of circumstances is the result of several competing mechanisms of formation and decomposition. The mechanisms are not well defined and extrapolation of data taken under one set of conditions to other situations can seldom be justified. At gas temperatures under 100°C, the airborne methyl iodide is relatively stable and may at times become the predominant iodine species airborne. Charcoal is the most generally favored adsorbent for removing organic iodides, yet the usual industrial charcoals are found to permit methyl iodide to bleed through with time, particularly under high humidity conditions. Various chemicals have been used to treat the charcoal to enhance its efficiency for removal and retention of methyl iodide. Investigations of impregnating materials continues. Vapor phase reactions of methyl iodide with other compounds are being studied. The objective of these studies is to find reactions whose iodine-containing products can be collected on filters or scrubbed from containment atmospheres. Although much research has been devoted in recent years to clarifying the mechanisms of formation and the behavior of methyl iodide there remain many unanswered questions and a good many apparent conflicts in reported observations. (auth)

8450 (BNWL–329) EXPERIMENTAL INVESTIGATION OF THE TURBULENCE STRUCTURE IN THE LOWER ATMOSPHERE. Elderkin, Charles Edwin (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Dec. 1966. Contract AT(45-1)-1830. 299p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Measurements of turbulence in all three components of the wind were made at several heights, in neutral, unstable, and stable conditions, and in a variety of wind speeds. The data

were analyzed on an analog computer for power spectral density distributions, cospectral density distributions and Reynolds' stresses. Similarity of the power spectral distributions was observed for each of the components with some notable deviations. The spectra for the vertical component measured at 12 meters and above, where bouyancy becomes effective, demonstrated definite convective energy peaks. These occurred in addition to the mechanical energy peaks which corresponded in the normalized spectral distributions to those for the tests close to the ground where mechanical energy dominated the structure. A shift to higher wave numbers was detected for stable cases in the spectra for all three components. The shift was most noticeable at 12 meters where greater stabilities were more possible than close to the ground. The spectral function for the inertial subrange, described by Kolmogoroff's relation, $S(\kappa) \propto \epsilon^{\frac{2}{3}} \kappa^{-\frac{5}{3}}$, was detected consistently in the longitudinal and vertical component spectra. Reasonable values resulted for the universal proportionality constant, a, estimated best by a = .51, and dependence on $\epsilon^{\frac{2}{3}}$ was demonstrated. The additional factor of $\frac{4}{3}$ required between the longitudinal and vertical one-dimensional spectra was missing, however. Only two cases for the lateral wind component showed a minus five-thirds dependence. The additional requirement for the inertial subrange, that the cospectra become zero, was observed to hold only down to $nz/\bar{U} = 1.0$ to 3.0 while the minus five-thirds law for the power spectra extended somewhat below this value. (auth)

8451 (CEX-59.4.12) AERORADIOACTIVITY SURVEY AND AREAL GEOLOGY OF THE PITTSBURGH AREA, PENNSYLVANIA, OHIO, WEST VIRGINIA, AND MARYLAND (ARMS-I). Bates, Robert G. (Geological Survey, Denver, Colo. Division of Biology and Medicine (AEC), Washington, D. C.). Sept. 1964. 19p. Dep. mn. CFSTI $1.00 cy, $0.50 mn.

During the summer of 1960 the U. S. Geological Survey made an airborne radioactivity survey of a large area in western Pennsylvania, eastern Ohio, northern West Virginia, and western Maryland. The survey area, totaling 14,400 square miles, is centered on the greater Pittsburgh metropolitan area. The survey was made on behalf of the U. S. Atomic Energy Commission as part of its Aerial Radiological Measurement Surveys (ARMS-I) program, a program of airborne radioactivity surveys of nuclear installations within the United States. Within the survey area are the Shippingport, Bettis, Apollo, Cheswick, and Waltz Mill nuclear facilities. Radioactivity levels range from 150 to 900 counts/sec and average between 500 and 600 counts/sec. Strata of Permian age have the highest radioactivity level and those of Mississippian age the lowest. Appalachian structural trends are reflected by linear radioactivity units in the southeastern corner of the survey area. (auth)

8452 (ORNL-TM-1686) ENVIRONMENTAL STUDIES: RADIOLOGICAL SIGNIFICANCE OF NUCLEAR ROCKET DEBRIS. Progress Report, July 1, 1965–June 30, 1966. Fish, B. R.; Clark, T. G.; Boyett, R. H.; Wilkie, W. H. Jr.; Thompson, J. L. (Oak Ridge National Lab., Tenn.). Dec. 1966. Contract W-7405-eng-26. 65p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Radiological safety studies being conducted for the Space Nuclear Propulsion Office, Flight Safety Branch, are summarized for the period, July 1, 1965 to June 30, 1966. An assessment was made of the significance of radioactive debris that may enter the biosphere following accidental destruction of a nuclear propulsion system. The production and dosimetry of micron-size particles containing individual radionuclides or a spectrum of fission products were studied. Two dosimetric techniques were used to extrapolate to minute volumes of tissue the dose absorbed from small spheres of reactor fuel material. The first utilized an air ionization chamber. The second used a technique in which progressively smaller discs of an organic scintillator yield pulse height spectra. Spherical particles from 1 mm to 1 cm diameter were made in thermal gradient columns or in split molds of aluminum or teflon. Labeling of these sources was done by addition of radioisotopes to a uranium-carbon mix prior to insertion in the mold or by neutron irradiation following particle fabrication. Deposition and adhesion of radioactive debris on the skin were studied. The degree of initial retention on the arm of particles falling vertically in a uniform fallout was determined. Coated UC_2 fuel beads were used in tests to determine the initial deposition and retention time on the skin. A wide variation was noted between individuals in the average length of time these particles remained on the arm under identical environmental conditions. Skin decontamination experiments showed that simple sanitary habits suffice to remove particles ranging from 1 to 1000 microns in diameter. Preliminary determination of gastrointestinal tract transit time in man, using insoluble particles, showed a significant fraction to be retained for periods longer than the 31-hour standard value. (TSS)

8453 (AEC-tr-6641, pp 43-52) RADIOACTIVITY OF THE AIR IN THE CRIMEAN COAST REGION OF THE BLACK SEA IN 1959–1960. Belyaev, L. I.; Gedeonov, L. I.; Shvedov, V. P.; Yuzefovich, A. A. Translated from Radioaktivnaya Zagryaznennost' Morei i Okeanov, Izdatel'stvo Nauka, Moscow, 1964.

The concentration of radioactive substances in the air was determined and the density of radioactive fallout measured on the Crimean Coast of the Black Sea. Purification of the troposphere is rapid owing to fallout on land surfaces. Introduction of radioactivity into the troposphere in the western part of the Sahara is followed by an intensive deposition of this radioactivity in the Black Sea zone and the entire Mediterranean region due to the predominant air currents. (F.S.)

8454 (AEC-tr-6641, pp 36-42) ATMOSPHERIC RADIOACTIVITY OVER THE BLACK SEA. Shvedov, V. P.; Gedeonov, L. I.; Eroshchev-Shak, V. A.; Patin, S. A. Translated from Radioaktivnaya Zagryaznennost' Morei i Okeanov, Izdatel'stvo Nauka, Moscow, 1964.

Measurements of the radioactivity in the air over the Black Sea were made to collect data on the content of artificially and naturally produced radioisotopes in the air and to compare fallout on the sea on days with and without atmospheric precipitation. Concentrations of radon decay products over the Black Sea were much higher than the concentration of long-lived radioisotopes and were the same as the concentration over land. The ratio of fallout on "dry" days to that on "wet" days was ~0.3. Of the total amount of long-lived radioactivity which fell out, 80% fell on rainy and 20% on dry days. (F.S.)

8455 (AEC-tr-6641, pp 32-5) MEASUREMENTS OF THE CONCENTRATION OF NATURAL AND ARTIFICIAL RADIOACTIVE ELEMENTS IN AIR OVER THE INDIAN AND THE PACIFIC OCEANS IN 1959 AND 1960. Krasnopevtsev, Yu. V. Translated from Radioaktivnaya Zagryaznennost' Morei i Okeanov, Izdatel'stvo Nauka, Moscow, 1964.

Measurements of concentrations of natural and artificial radioactivity in the air over the Indian and Pacific Oceans showed maximum concentrations in the vicinity of the shores. Minimum values were observed at greatest distances from the shores. Fogs and drizzles precipitate more artificially produced radioactivity than natural activity. Concentrations are affected by the direction of winds. Continental winds produce higher concentrations than ocean winds but the "continental effect" on aerosol concentration has not been adequately substantiated. (F.S.)

8456 (AEC-tr-6641, pp 23-31) ATMOSPHERIC RADIOACTIVITY OVER THE ATLANTIC OCEAN. Kosourov, G. I. Translated from Radioaktivnaya Zagryaznennost' Morei i Okeanov, Izdatel'stvo Nauka, Moscow, 1964.

A study of beta-active long-lived radioactivity over the Atlantic Ocean is described in which it was found that fallout on dry days was 30 to 50% of that on rainy days. The radioactive condition of the lower layers of the atmosphere is a direct reflection of processes occurring in higher layers of the atmosphere. The meteorological conditions in the lower layers play only a subsidiary role. The part played by precipitation is reduced to the redistribution, over a 10 to 20 day period, of the amount of radioisotopes, the precipitation of which is already predetermined. (F.S.)

8457 (AEC-tr-6641, pp 14-22) COMPOSITION AND CONCENTRATION OF THE RADIOACTIVE CONTAMINATION IN THE AIR OVER THE INDIAN AND PACIFIC OCEANS IN 1959–1960, ACCORDING TO DATA OBTAINED BY THE "VITYAZ" EXPEDITION. Lavrenchik, V. N.; Sofiev, G. N.; Shubko, V. M. Translated from Radioaktivnaya Zagryaznennost' Morei i Okeanov, Izdatel'stvo Nauka, Moscow, 1964.

Geographical distribution of nuclear test products in the western part of the Pacific Ocean and the northern and central parts of the Indian Ocean was found to be related to the rates of the descent of the air masses which are reflected in the variations of atmospheric pressures. An increase in atmospheric pressure usually results in an increase in the concentration of contamination. The concentration in the stratosphere is greater than that in the troposphere and descending air masses at sea level, facilitate increases in concentration of contamination. In the regions investigated, average fallout in the northern hemisphere was double that in the southern hemisphere. (F.S.)

8458 RADIOACTIVE FALLOUT AT PRAGUE IN 1965. Spurny, Kvetoslav; Machala, Oldrich (Inst. of Physical Chemistry, Prague). Zdrav. Tech. Vzduchotech., 9: 190-2(Sept, 1966). (In Czech).

The average fallout at Prague in 1965 was 0.42×10^{-8} Ci/m^2/28 d. The maximum value of 1.30×10^{-8} was registered in May, the minimum of 0.06×10^{-8} in October. No correlation between the precipitation and the fallout was apparent. In the past the minimum fallout values were found in 1960, a maximum was reached in 1963, since then there has been a continuing decrease. (JPRS)

8459 ^{90}Sr AND ^{137}Cs IN PRECIPITATION IN FINLAND. Salo, Anneli (Inst. of Radiation Physics, Helsinki). Nature, 212: 61(Oct. 1, 1966).

Methods of sampling rain water in Finland are described. Collections were made with a stainless steel funnel in a polythene bottle and a stainless steel funnel which drained directly into an ion-exchange column. Results of the two methods show that the ion-exchange method is unsatisfactory in winter as the Cs runs through the resin. In using the funnels and polythene bottles, the values for ^{137}Cs and ^{90}Sr in Finland agree with those found in other places of similar latitude and weather conditions. (F.S.)

8460 COMMENT ON PAPER BY L. B. LOCKHART, JR., R. L. PATTERSON, JR., AND A. W. SAUNDERS, JR., "THE SIZE DISTRIBUTION OF RADIOACTIVE AEROSOLS." Billings, Charles E. (California Inst. of Tech., Pasadena). J. Geophys. Res., 71: 6141-2(Dec. 15, 1966).

A method for separating polydisperse atmospheric aerosols into size fractions by means of filtration through graded fiber filters of progressively finer fibers is discussed. The finer particles pass through the initial filter and are captured in subsequent filters according to the sizes of the fibers and particles. After operation of the filter packs from 2 to 4 days, each layer is analyzed to determine the distribution of fission product activity. The increase in filter efficiency as a result of solid particle accumulation is a function of total atmospheric aerosol burden. (R.C.K.)

8461 ^{7}Be IN RAIN WATER FROM FUKUOKA. Yoshimura, Jun (Miyakonojo Technical Coll., Japan); Takashima, Yoshimasa; Nakagawa, Hideki; Ohashi, Shigeru. Mem. Fac. Sci. Kyushu Univ., Ser. C, 5: 171-5(Mar. 1966).

Attempts were made to estimate the content of cosmic radiation-produced Be in the earth's atmosphere. Very little ^{7}Be is thought to originate from nuclear detonations. The concentrations of ^{7}Be in rainwater samples from Fukuoka were measured from April, 1963 to January, 1964. The average concentration of ^{7}Be was 3600 atom/ml. The total deposition of ^{7}Be in 1963 at Fukuoka was estimated to be 8.3×10^5 atom/cm^2/yr. In 1963, the total amount of precipitation at Fukuoka was above the annual average of past 20 yr by a factor of 1.5. Therefore, the data obtained may be non-representative, since more ^{7}Be in the troposphere was probably carried down to the ground level by the heavy rainfall this year. Also considered is the seasonal variation of ^{7}Be concentration in rainwater. The max concentration was observed in the May sample, which agrees with earlier results. At this season, it is considered that greater atmospheric mixing occurred and more ^{7}Be was carried down by rainfall. The correlation between the ^{7}Be concentration and the amount of precipitation was also examined. A correlation would be expected in view of dilution effect due to rainwater; i.e., the less precipitation, the higher the ^{7}Be concentration. However, the observed results do not confirm this assumption and suggest a complex mechanism for descent of ^{7}Be from the atmosphere. (BBB)

8462 ^{90}Sr IN STOCK RAINWATER FOR DRINKING SAMPLED AT SOME LIGHTHOUSES DURING 1963. Nagasawa, Kakuma; Urakubo, Goro; Kido, Yasumasa; Ikebuchi, Hideharu (National Inst. of Hygienic Sciences, Tokyo). Eisei Shikensho Hokoku, 82: 107-9(Oct. 1964). (In Japanese).

Radioactive contamination of drinking water as the result of nuclear weapons tests was investigated in 1963. Stock rainwater was collected from 7 lighthouses in various parts of Japan during April 1963 to March 1964. The ^{90}Sr contamination was determined by the same methods as previously reported. The results of analyses showed that the ^{90}Sr contamination in Hokkaido was relatively lower than that in Honshu. In Soyanisaki (Hokkaido) the ^{90}Sr contamination of filtered water showed 1.1 to 49.3 $\mu\mu$C/l gross activity, 0.183 to 0.212 g/l residue, and 0.14 to 0.26 $\mu\mu$C/l ^{90}Sr activity. However, Miyakezima (Tokyo) samples showed 143.9 to 288.0 $\mu\mu$C/l gross activity, 0.141 to 0.480 g/l residue, and 2.83 to 6.71 $\mu\mu$C/l ^{90}Sr activity. The ^{90}Sr contamination in Hokkaido samples gradually increased from January, 1963, reached a max in February, then gradually decreased. In Murotomisaki (Kochi) the max contamination was observed in May, 1963 (108.1 $\mu\mu$C/l gross activity in filtered water and 29,808.6 $\mu\mu$C/l in unfiltered samples). The high ^{90}Sr contamination of unfiltered water might be due to the adsorption of ^{90}Sr by the sediment in rainwater. In Makurazaki (Kagoshima) the contamination was increased before July, 1963 (93.7 to 150.9 gross activity ($\mu\mu$C/l) in filtered water and 143.7 to 209.4 in unfiltered samples). However, it subsequently gradually decreased. (BBB)

8463 CONTRIBUTION TO THE ESTIMATION OF PARTICLE SIZE OF γ EMITTERS IN RADIOACTIVE FALLOUT (1963). Uchovsky, Dov. Wien. Tieraerztl. Monatsschr., 51: 542(1964). (In German).

Particle size of fallout particles was measured by collection of dry and wet particles that were separated by size-graded membrane filtration into various size ranges. The distribution of the radioactivity in the several size classifications was evaluated by means of autoradiographic study. The activity of the γ emitters ^{141}Ce, ^{144}Ce, ^{95}Zr, ^{95}Nb, and ^{103}Ru in the samples was measured by γ spectroscopy. Results from 9 samples collected from the vicinity of Vienna during the period from October 1962 to March 1963 showed that ^{141}Ce, ^{144}Ce, ^{95}Zr, and ^{95}Nb were mostly in form of particles larger than 5 μ or were deposited in particles of this type that could not be separated in aqueous suspensions. Only a small amount of ^{95}Zr and ^{95}Nb could be found in particles less than 1 μ in size. Almost half of the ^{103}Ru was found in particles smaller than 1 μ that were soluble. There were only a few active particles in the size range from 1 to 5 μ. Particles smaller than 1 μ had very little activity. (BBB)

8464 AIR EJECTOR FILTER SAMPLER: A BALLOON-BORNE COLLECTOR OF RADIOACTIVE STRATOSPHERIC DEBRIS. Wood, Rex C.; Olson, Richard K.; McFarland, Andrew R. (Litton Systems, Inc., Minneapolis). Contract AT(11-1)-401. J. Appl. Meteorol., 5: 866-71(Dec. 1966).

An air ejector filter sampler which consists of a balloon-borne device designed to collect particulate matter from very large volumes (10^5 ft^3) of stratospheric air at altitudes between 50,000 and 130,000 ft is described. This equipment utilizes an ejector pump to pull air through 2 ft^2 of Institute of Paper Chemistry (IPC) #1478 filter paper at rates on the order of 1000 cfm. Use of this unit has permitted an extension of the U. S. Atomic Energy Commission operational sampling program to higher altitudes than previously allowed by battery powered electro-mechanical systems. Performance of the sampler during a successful operational series conducted in 1965 by the U. S. Air Force at San Angelo, Texas, and Eielson AFB, Alaska, has confirmed pre-program estimates of system reliability. (auth)

Mineralogy

8465 ZELLERITE AND METAZELLERITE, NEW URANYL CARBONATES. Coleman, R. G.; Ross, D. R.; Meyrowitz, R. (Geological Survey, Menlo Park, Calif. Geological Survey, Washington, D. C.). Amer. Mineral., 51: 1567-78(Nov.-Dec. 1966).

The mineral zellerite, named after Howard D. Zeller, occurs at the Lucky Mc uranium mine, Fremont County, Wyoming, as pincushion clumps of needlelike orthorhombic crystals on oxidized uranium ore and is intimately associated with gypsum and secondary iron oxides. The recalculated analysis gives CaO 10.3, UO_3 53.9, CO_2 16.9, H_2O^+ (110°) 12.3, H_2O^- (110°) 6.6 after SiO_2 + insoluble 0.5, R_2O_3 1.0, K_2O 0.2, Na_2O 0.4 were subtracted as impurities. This gives a ratio of $CaO : UO_3 : CO_2 H_2O$ of 1.00 : 1.03 : 2.09 : 5.81. This ratio and other considerations regarding the water content yield the formula $CaUO_2(CO_3)_2 \cdot 5H_2O$ for the fully hydrated mineral. On partial dehydration, a probable metacalcium uranyl dicarbonate of formula $CaUO_2(CO_3)_2 \cdot 3H_2O$, metazellerite, is produced. Single-crystal x-ray studies of both hydrated and dehydrated material are discussed. The fully hydrated mineral is lemon yellow with a dull luster and no cleavage. Measured specific gravity is 3.25; calculated 3.24 gm/cm^3. The optical properties are: α 1.536, β 1.559, γ 1.697, biaxial (+), 2V = 30 to 40°, Z = c, dispersion weak v > r; pleochroism: Z = light yellow, Y = colorless, X = colorless. The mineral has a weak patchy green fluorescence under long and short ultraviolet light. It forms as an oxidation product of uraninite-coffinite in the weathering zone, where P_{CO_2} is greater than that in the atmosphere and pH is greater than 7. (auth)

8466 REDUCTION OF URANIUM BY NATURAL ORGANIC SUBSTANCES. Andreev, P. F.; Chumachenko, A. P. Geochem. Int., 1: 3-7(1964).

The association of redeposited pitchblende with sulfides suggests that the processes of desulfurization and reduction of U were synchronous, and that organic matter participated indirectly in the reduction of the U. The possibility of direct reduction of uranyl ions by organic matter was investigated under various conditions, using organic compounds most nearly like those found in nature. The theoretical possibility of this process was also estimated by thermodynamic calculations of the free energy changes during the course of combined oxidation and reduction. The thermodynamic parameters of U oxides used in the calculations are tabulated. Thermodynamic calculations showed that U(VI) can be reduced to U(IV) by organic matter at 25°C and a pressure of one atm. It was shown that sexivalent U can be reduced to U(IV) by peat, wood, cellulose, kerogen, oxycellulose, and starch at the low temperatures of the earth's surface. The degree of reduction of U depends on the kind of organic matter and the acidity of the medium. The most effective reducing

agents in a broad pH range were peat, kerogen, wood, and cellulose. Starch reduced U most effectively in nearly neutral media, and oxycellulose was most effective in acid media. The reduction of U(VI) by insoluble heavy organic molecules takes place within U-organic complexes with the participation of alcohol carbonyl and carboxyl groups. The U(VI) salts are extracted from the solutions by organic matter, and the oxides and hydroxides of U(IV) formed as a result of reduction remain as insoluble components in the solid phase. In nature, plant tissues and the products of their oxidation may reduce U directly without the aid of hydrogen sulfide. (BBB)

8467 THE SOURCE OF THE URANIUM IN THE KHADUM SHALES. Serikov, Yu. I. (Gubkin Inst. of Petrochemical and Gas Ind., Moscow). Geochem. Int., 1: 229-32(1964).

The origin of U in U-rich marine shales, as seen in γ-ray logs of oil and gas well drillings, was examined. An investigation of the Khadum shale from deep drill holes in East Ciscaucasia made in 1962 provided a solution of this problem of uraniferous shales. Anomalous radioactivity of the Khadum shale was examined by geophysical, radiometric, chemical, and granulometric analyses. A linear relation was established between the content of organic carbon and the radioactivity, with the U content per unit weight of organic matter equal to 153×10^{-12} g-equiv Ra/g. It is concluded that the U in the shales is syngenetic with the sediments and is genetically related to the organic matter. It is possible that a low rate of sedimentation could account for the enrichment of organic matter (and radioactivity) in the Khadum shales. Because the pyritic shales are a very acid medium, U is present in them in a mobile form. A slight increase in the content of sand in the Khadum clays disturbs the equilibrium between U and Ra and causes a deficiency of U. Therefore, U may be carried out of the anomalously radioactive shales by circulating waters. (BBB)

8468 ON THE NATURE OF THE ISOTOPE ^{40}Ar IN URANIUM-CONTAINING MINERALS. Gerling, E. K.; Shukolyukov, Yu. A.; Tolstikhin, I. N.; Ashkinadze, G. Sh. (Lab. of Geology of the Precambrian, Leningrad). Geokhimiya, No. 12, 1413-20(Dec. 1966). (In Russian).

Attempts to calculate the age of uranium minerals by the K–Ar method give excessively high values. This bears witness of the presence of excess radiogenic Ar in uranium-containing minerals. The main part (70 to 95%) of the remaining radiogenic ^{40}Ar is very firmly retained by uranium minerals. There is a complete analogy between the kinetics of excess ^{38}Ar and ^{40}Ar escape isolation during the heating of uranium minerals. The radiogenic isotopes ^{40}Ar/^{38}Ar ratio changes very little in minerals of the most different composition and of an age from 0.2×10^9 to 2×10^9 years and averages ≈1000. (auth)

8469 ON THE NATURE OF SULFIDES IN THE BALTIC SHALE BASIN ACCORDING TO DATA OF THE ISOTOPIC SULFUR COMPOSITION. Grinenko, V. A.; Gazizov, M. S. (Vernadskii Inst. of Geochemistry and Analytical Chemistry, Academy of Sciences, USSR, Skochinskii Mining Inst., Moscow). Geokhimiya, No. 12, 1421-30(Dec. 1966). (In Russian).

The mineralogical composition, the manifestation forms of sulfides and calcite and the isotopic composition of sulfur and carbon were studied. The chief sulfide mass is restricted to karst dislocations and fractures which intersect the sedimentary rocks of the Paleozoic and the carbonate rocks of the Ordovician. Sulfides have a wide range of δ^{34}S values from +2.3 to −3.6‰; in most cases being enriched in the ^{32}S isotope. The carbon of limestones shows δ^{13}C values in the ranges from −0.16 to −0.30‰ and of secondary calcite from −0.17 to −0.99‰. It has been ascertained that the formation of sulfides is connected with the process of reduction of secondary sulfates and of sulfates of stratal-fissure waters. The organic matter necessary for the activity of sulfate-reducing bacteria could be supplied from a combustible shale layer. A great part of secondary calcites has formed with participation of carbon dioxide which had isolated in the process of organic matter oxidation. (auth)

8470 GEOLOGIC LIMITATIONS ON THE AGE OF URANIUM DEPOSITS IN THE JACKPILE SANDSTONE, NEW MEXICO. Nash, J. Thomas; Kerr, Paul F. (Columbia Univ., New York). Econ. Geol., 61: 1283-7(Nov. 1966).

An investigation of the age and original source of uranium ions of the Jackpile Sandstone uranium deposits in New Mexico is reported. Recently exposed structural-stratigraphic relations in the Poguate open pit mines, supplemented by mineralogical observations suggest a post-Jackpile but pre-Dakota emplacement for ore in the Jackpile Sandstone host rock. Stratigraphic relations, stratigraphic cover at time of ore emplacement, deposition and resistance of black ore near the surface, and comparisons of geologic and isotopic ages are discussed. (R.C.K.)

Oceanography

Refer also to abstracts 8806, 8807, and 8809–8811.

8471 (AEC-tr-6641) RADIOACTIVE CONTAMINATION OF THE SEA. Baranov, V. I.; Khitrov, L. M. (eds.). Translation of Radioaktivnaya Zagryaznennost' Morei i Okeanov, Izdatel'stvo Nauka, Moscow, 1964. 203p. (IPST-Cat.-1666). Dep. CFSTI $6.00 cy, $1.25 mn.

Twenty-five chapters on various aspects of radioactive contamination of the sea were translated. Separate abstracts were prepared for 23 chapters on: general problems, natural radioactivity of the seas and oceans, atmospheric fallout over the sea, radiohydrochemistry, biology, physical methods of radioactivity studies, and methodology. Two chapters on biological indication on weak radioactive contamination of sea water and turbulent diffusion of conservative and nonconservative admixtures were not included in NSA. (H.G.D.)

For abstracts of individual chapters see: 8453–8457, 8472–8481, 8529, 8530, 8583, 8806, 8807, and 8809–8811.

8472 (AEC-tr-6641, pp 1-6) FOREIGN INVESTIGATIONS OF RADIOACTIVITY IN THE OCEAN IN CONNECTION WITH THE PROBLEM OF RADIOACTIVE WASTE DISPOSAL. Fedorov, K. N. Translated from Radioaktivnaya Zagryaznennost' Morei i Okeanov, Izdatel'stvo Nauka, Moscow, 1964.

The 1957 report by the National Research Council of the USA on the Effects of Atomic Radiation on Oceanography and Fisheries is summarized. (H.G.D.)

8473 (AEC-tr-6641, pp 7-9) NATURAL RADIOACTIVITY OF OCEANS. Baranov, V. I. Translated from Radioaktivnaya Zagryaznennost' Morei i Okeanov, Izdatel'stvo Nauka, Moscow, 1964.

Contents of naturally-occurring radioisotopes and fission products from fallout in oceans are discussed. Data show that most of the natural radioactivity of sea water is due to ^{40}K. Uranium-238 contributes the largest part of the alpha activity. In bottom sediments ratios of radioisotopes differ markedly from those in the sea water and the predominating radioisotopes are ^{238}Th and Ra. (H.G.D.)

8474 (AEC-tr-6641, pp 10-13) NATURAL RADIOACTIVITY OF THE WATERS AND SEDIMENTS IN THE BLACK SEA AND THE SEA OF AZOV. Starik, I. E.; Nikolaev, D. S.; Grashchenko, S. M.; Kuznetsov, Yu. V.; Lazarev, K. F.; Legin, V. R. Translated from Radioaktivnaya Zagryaznennost' Morei i Okeanov, Izdatel'stvo Nauka, Moscow, 1964.

Radioactivity was measured in water and bottom sediments from the Black Sea and the Sea of Azov during 1958 and 1959. Uranium concentrations varied from 1.5 to 2.8×10^{-6} g/l with no apparent regularity of variation in either horizontal or vertical traverses. The constancy of the U concentration in both seas was shown to be related to the presence of the carbonate complex of uranium. Although the uranium contents in the waters of both seas were similar, the concentrations in the upper portion of the bottom sediments were different, a difference explained by variation of hydrochemical conditions. Thorium-232, ^{232}Th, and Ra were also determined. (H.G.D.)

8475 (AEC-tr-6641, pp 64-71) β-ACTIVITY OF WATER, OOZE AND VEGETATION IN THE RYBINSK WATER RESERVOIR. Polyakov, Yu. A.; Anichkova, N. I.; Leont'ev, A. M. Translated from Radioaktivnaya Zagryaznennost' Morei i Okeanov, Izdatel'stvo Nauka, Moscow, 1964.

Results of studies of the β activity and K background in the Rybinsk reservoir between 1957 and 1960 are discussed. Activity measurements were made in samples of water, ooze, and in dried and ashed samples of aquatic plants (Potamogeton perfolians L., P. lucens L., P. pusilus L., P. Fristi Purr., P. natans L., P. heterophyllus, Sagittaria sagittifolia L., Elodea canadensis L., Ranunculus Gmelinii, and Ceratophyllum demersum L.) and in lichens and mosses (Cetrartia Islandica, Pleurozium Schreberi, and Sphagnum angustifolium). Distribution of activity among various organs of the aquatic plants varied irregularly. It was concluded that mosses and lichens were good biological indicators of contamination by β-emitters. (H.G.D.)

8476 (AEC-tr-6641, pp 72-7) FOREIGN INVESTIGATIONS OF THE BIOLOGICAL EFFECTS OF ATOMIC RADIATION IN THE OCEAN. Beklemishev, K. V. Translated from Radioaktivnaya Zagryaznennost' Morei i Okeanov, Izdatel'stvo Nauka, Moscow, 1964.

Data published by the USA and the IAEA on contamination of oceans by fission products from the testing of nuclear explosives and by waste disposal are critically reviewed. (H.G.D.)

8477 (AEC-tr-6641, pp 59-63) DETERMINATION OF ^{90}Sr CONTENT IN THE BLACK SEA. Shvedov, V. P.; Yuzefovich,

A. A.; Eroshchev-Shak, V. A.; Patin, S. A.; Ivanova, L. M.; Stepanov, V. A.; Maksimova, A. M. Translated from Radioaktivnays Zagryaznennost' Morei i Okeanov, Izdatel'stvo Nauka, Moscow, 1964.

The content of ^{90}Sr at a depth of 35m in the Black Sea was determined and found to be almost the same as the ^{90}Sr content of the surface, possibly indicating rapid mixing in the surface layer of the sea. Content of ^{90}Sr near the bottom layer at a depth of 100m in the Sea of Marmara in the vicinity of the Bosporus was appreciable, possibly due to rapid descent of the surface waters of the Sea of Marmara on penetration into the Black Sea through the Bosporous without appreciable dilution by the lighter Black Sea water. The evaluation of ^{90}Sr content in sea water is of value not only for biological evaluation of water contamination, but leads to a better understanding of the mixing of waters. (F.S.)

8478 (AEC-tr-6641, pp 192-3) DETERMINATIONS OF ARTIFICIAL RADIOACTIVITY IN SEA WATER. Bobovnikova, Ts. I.; Sereda, G. A. Translated from Radioaktivnaya Zagryaznennost' Morei i Okeanov, Izdatel'stvo Nauka, Moscow, 1964.

The extremely low concentrations of artificial radioisotopes in sea water and the presence of the natural radioisotopes, ^{40}K, ^{87}Rb, U and Ra as well as large quantities of salt make it difficult to measure the artificial radioisotopes. Techniques for concentration and methods of measuring ^{90}Sr and ^{137}Cs in sea water are summarized. (F.S.)

8479 (AEC-tr-6641, pp 177-84) METHODS FOR THE DETERMINATION OF ^{90}Sr IN SEA WATER. Azhazha, E. G. Translated from Radioaktivnaya Zagryaznennost' Morei i Okeanov, Izdatel'stvo Nauka, Moscow, 1964.

In the determination of ^{90}Sr in sea water, volumes of at least 100 liters are necessary because of the low concentration of the ^{90}Sr. Due to the low β radiation energy of ^{90}Sr, its activity is determined from ^{90}Y which posseses a more penetrating β radiation. The ^{90}Y in equilibrium with ^{90}Sr is isolated, its radiation measured, the amount of ^{90}Sr corresponding to the isolated ^{90}Y is determined, and the ^{90}Sr in the 100 liter sample is established. The carbonate precipitation method used to concentrate ^{90}Sr from sea water aboard a research vessel is described. (F.S.)

8480 (AEC-tr-6641, pp 172-6) PROCEDURE FOR TAKING WATER SAMPLES FROM ANY DESIRED HORIZONS IN STUDIES OF THE DISTRIBUTION OF ISOTOPES AND TRACE ELEMENTS IN THE OCEAN. Khitrov, L. M. Translated from Radioaktivnaya Zagryaznennost' Morei i Okeanov, Izdatel'stvo Nauka, Moscow, 1964.

A bathometer is described for obtaining 200-liter samples of ocean water. The bathometer is fabricated of stainless steel and is 2600 mm high with a 328 mm dia. It weighs 80 kg when empty. It is lowered into the water on a steel cable 4.8 to 7.2 mm in dia to depths of 3000 to 7,500 mm by a hydrological winch. The 200-liter sample is concentrated by adding Sr Cl_2 ammonium carbonates, ammonium chlorides, and aqueous ammonia to precipitate the carbonates. (F.S.)

8481 (AEC-tr-6641, pp 170-1) RESEARCH ON THE CIRCULATION IN THE OCEAN BY THE LABELED CLOUD METHOD. Shirei, V. A. Translated from Radioaktivnaya Zagryaznennost' Morei i Okeanov, Izdatel'stvo Nauka, Moscow, 1964.

A method is described for determining the average direction and speed of the transport of water at a given horizon and the turbulent diffusion at depths to 500m. The method utilizes radioisotopes having a short half-life with fairly high energy γ radiation such as ^{84}Rb and ^{86}Rb. The isotopic labeled solution is released from an anchored buoy and detection of the direction of isotope flow is made. (F.S.)

8482 RADIOISOTOPES AND THE RATE OF MIXING ACROSS THE MAIN THERMOCLINES OF THE OCEAN. Broecker, Wallace S. (Columbia Univ., Palisades, N. Y.). J. Geophys. Res., 71: 5827-36(Dec. 15, 1966).

A box model of oceanic mixing is presented which permits the distribution of long-lived natural radioisotopes, e.g., ^{14}C and ^{226}Ra, to be quantitatively compared with the distribution of man-made radioisotopes (^{90}Sr, ^{137}Cs). Instead of the simple two-layer models used widely by geochemists, four additional reservoirs which approximate the main oceanic thermocline are incorporated in the model. For situations in which the transport of particles does not influence the distribution of a given isotope within the sea, only two parameters are needed to characterize the distribution: the fraction of that isotope added directly to the deep ocean and the rate of transfer of water along the six-box chain. The distributions of ^{14}C and of $^{90}Sr-^{137}Cs$ are internally consistent. Both suggest a mean eddy diffusion coefficient for the main oceanic thermocline of the order of 1 cm^2/sec. The vertical distributions of ^{90}Sr and ^{137}Cs in the upper 800 meters of the oceans are consistent with mixing rates dictated by ^{14}C, and the absolute amounts of these isotopes are consistent with those found in soils. The finding that ^{226}Ra shows the same fourfold increase from the warm to cold reservoir of the Pacific Ocean as barium suggests that this isotope will not be of use in establishing oceanic mixing rates. (auth)

8483 PROTACTINIUM IN DEEP SEA SEDIMENTS. Rona, Elizabeth; Muse, Lowell; Brandau, Betty Lee (Oak Ridge Inst. of Nuclear Studies, Tenn.). pp 333-8 of Physico-Chimie du Protactinium. Paris, Centre National de la Recherche Scientifique, 1966.

A method is presented utilizing protactinium to determine absolute ages of marine sediments. This method necessitates the separation of submicrogram quantities of protactinium in pure form from other elements which are present in the sediments in much higher quantities. The method is given and ages, calculated for a sediment core taken from the Gulf of Mexico, are presented as an example. (auth)

Seismology

8484 (AWRE-O-54/66) SPECIAL PURPOSE LEAST SQUARES PROGRAM. Douglas, A. (Atomic Weapons Research Establishment, Aldermaston (England)). Nov. 1966. 35p. Dep. mn. BIS $1.00. HMSO 5s.

The relative size, M(I,J), of the seismic signal recorded at station I from the Jth explosion at a particular firing site is assumed to be given by the equation; $M(I,J) = B(J) + S(I) + \epsilon(I,J)$, where B(J) depends on the size of the explosion and S(I) is a station term dependent mainly on the distance of the Ith station from the firing site. M(I,J) is measured from seismic records and will usually be in error; and $\epsilon(I,J)$ is the error term. A least squares program is described for estimating: B(J) and S(I), the confidence limits on these quantities, and the differences, and confidence limits on the differences, between all possible pairs of B(J). Although written for a specific purpose, the method is general and can be used to estimate any quantities that can be expressed as equations of the above type. (auth)

8485 EARTHQUAKE OR EXPLOSION? Thirlaway, H. I. S. (United Kingdom Atomic Energy Authority, Blacknest, Eng.). New Sci., 18: 311-15(May 9, 1963).

Technical problems in seismologic differentiation between small earthquakes and nuclear test explosions are discussed. An early method for distinguishing earthquakes from explosions was to note the initial direction of movement detected by the seismograph. Most earthquakes are generated by shearing blocks of rock; that action will compress the rocks in some directions while expanding them in others. Thus some recording stations will show an initial ground motion away from the origin of the earthquake (+) and others will display one toward the origin (–). Explosions, on the other hand, produce compressions in all directions and positive first motions at all stations. Use of linear arrays of seismologic instruments to distinguish earthquakes from explosions is explained. With this system, initial pulses are indistinguishable, but the subsequent rate of arrival of energy is higher in the case of the earthquake. Earthquake signals are more strongly correlated across the array. As the depth of the event increases, the rate of arrival of energy decreases because the environment of the source becomes more homogeneous. This effect has been observed experimentally using linear array processing techniques. Two distant explosions have now been recorded in the form required for processing by the technique which is described. However, further research is necessary to improve the signal-to-noise ratio in the detection system, before the technique can be applied with confidence to the identification problem. Determining the depth of events is also considered. (BBB)

8486 ON THE TRAVEL TIMES OF P AS DETERMINED FROM NUCLEAR EXPLOSIONS. Lehmann, I. (Lamont Geological Observatory, Palisades, N. Y.). Bull. Seismol. Soc. Amer., 54: 123-39(Feb. 1964).

The travel times of P waves as recorded from 14 shots on the Nevada Test Site (NTS) and from the Gnome (GN) shot were examined. The travel times on different lines extending from the test sites were considered separately. Of special interest were the travel times obtained on the line joining the NTS and GN site. The 2 sets of travel times were in good agreement, but from epicentral distance 700 km onwards they were delayed and scattered. This was an indication of the presence of a low velocity layer at small depth on the line. Travel times on lines extending in other directions from the NTS differed somewhat but not very greatly from those on the NTS-GN line. On the line from the Gnome site to the northeast travel times were considerably smaller owing to a strong increase of velocity with depth close to the Gnome site. Travel times in agreement with those ob-

served were calculated. Some California stations at distances around 1700 km observed P of the Gnome shot with an exceptional delay of 4½ sec. The New Madrid (Missouri) earthquake of February 2, 1962, had its epicenter on the Gnome northeast line, but the surface velocity of P_n of the earthquake was smaller on the line than that of the Gnome shot. P_n of the earthquake was well recorded in all directions from the epicenter; there was no low velocity layer at small depth in these regions. In an earlier study of some earthquakes in northeastern America P_n and also S_n were found to be well-recorded phases. It seems as if shallow, low-velocity layers are confined to the western mountain regions. (BBB)

ENGINEERING

Nuclear Explosions

Refer also to abstract 8485.

8487 (N–66-31960) DE STANDZEKERHEID VAN DIJKEN ONDER INVLOED VAN RAYLEIGH-GOLVEN OPGEWEKT DOOR NUCLEAR EXPLOSIES. (Strength of Dikes Under the Pressure of Rayleigh Waves Initiated by Nuclear Explosions). Trense, R. W. (Technisch Documentatie- en Informatie-Centrum voor de Krijgsmacht, The Hague (Netherlands)). Feb. 1966. 38p. (In Dutch). (TDCK–45622).

The connection between an earthquake and the size of a bomb is considered, along with the effects that an earthquake would have on a dike. Through mathematical analysis, it was determined that the outer layers of the dike are of great importance as protection against vibrations. In general, it was found that the resistance of dikes against the influence of Rayleigh waves is larger than the resistance against the movements of the base of the dike. The importance of knowing to what extent the roots of grasses dig into the dike is pointed out, and research is recommended to study the connection between the dynamic ground properties and the base values of the dikes. (STAR)

8488 (PNE–5005) ENGINEERING–GEOLOGIC INVESTIGATIONS. Project DANNY BOY. Final Report. Nugent, R. C.; Banks, D. C. (Army Engineer Waterways Experiment Station, Vicksburg, Miss.). Aug. 1966. 104p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Preshot and postshot investigations of the Danny Boy site were made to obtain information on the change in engineering properties of the basalt media adjacent to the crater and to determine engineering properties of the important physiographic features of the crater such as ejecta and fallback materials. Field investigations included geological studies of the area and core borings in which borehole photographs were made and water pressure tests were conducted. Particle size distribution and density of the ejecta materials were determined. Rock media at the Danny Boy site consist of a moderately fractured basalt that caps a relatively thick sequence of soft tuffs and tuffaceous alluvium. The basalt cap varies from 204 to 229 ft in thickness and is composed of at least two separate flows. The upper flow, consisting of a vesicular zone overlying a nonvesicular zone, is relatively constant in overall thickness throughout the mesa, varying from 140 to 160 ft. The lower flow, averaging 68 ft in thickness, is more variable in lithologic composition, encompassing possibly two individual flow units. No borehole camera photographs were made of the preshot holes, and therefore little detailed information is known concerning the preshot structural conditions at the Danny Boy site. Laboratory tests indicated that the properties of the basalt vary widely, depending on the vesicularity of the basalt. The unconfined compressive strength generally increases as the density of the basalt increases. Postshot investigations indicated that the uplift of the ground surface at the crater perimeter varied from 8.5 to 20.2 ft, and averaged 14.5 ft. No indication of faulting or overturning was noted in trenches excavated through the ejecta. The average preshot joint spacing based on measurements of natural joints and postshot vertical borings varied between 1.25 and 1.6 ft. The blast-induced fractures developed in a subparallel or parallel fashion to the preshot joint system. The structure pattern at the site remained essentially unchanged after the blast, except for an increase in the total number of fractures present and a slight increase in the overall variability of the joint pattern. The natural joints tended to open up as a result of the blast. The Danny Boy crater was too small in relation to the characteristics of the material cratered to provide much insight into crater stability. All components of the slope are relatively stable, and slope readjustments, while probable, should be both slow and surficial. (auth)

8489 (SC–RR–66-415) COMPARISON OF AIR BLAST FROM TWO SIZES OF ROW CHARGES. Vortman, L. J. (Sandia Corp., Albuquerque, N. Mex.). Oct. 1966. Contract AT(29-1)-789. 33p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Air blast as a function of distance was measured from the end of, and perpendicular to, a row of five 64-pound charges at the same cube-root scaled burial depth and spacing as in project Dugout, but in dry-lake playa rather than in basalt. Wave forms had similar conformation but differences in amplitudes and times in the two events; azimuthal variations also were different. The results suggest that the blast phenomena from row charges may scale as a smaller-than-$\frac{1}{3}$ power of the charge weight when burial depth and spacing are scaled by cube root. This result is contrary to the adherence to cube-root scaling found for air blast from buried single charges. In view of differences in media, dissimilarities in amplitudes and times, and azimuthal variations, with data from only two detonations to work with, too much credence should not be placed in these findings until additional events substantiate them. (auth)

8490 (SC–RR–66-477) CRATERS FORMED BY ROW CHARGES IN THE VERTICAL FACE OF A 90-DEGREE WEDGE. Harris, Virgil A. (Sandia Corp., Albuquerque, N. Mex.). Nov. 1966. Contract AT(29-1)-789. 35p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

An experiment was conducted to simulate a small-scale overburden stripping by nuclear explosives as the technique might be used to facilitate open-pit mining of oil shale as it occurs near valleys in the Colorado Plateau, and to investigate the changes in crater dimensions and ejecta dispersion with changes in burial depth. Five rows of charges, each containing six 8-pound spheres of cast TNT spaced 4 feet apart, were buried 3.0 feet back from the face of a cliff bank. Charges for each of five shots were buried at depths of 3, 3.5, 4, 4.5 and 5 feet, respectively, and all charges for each shot were detonated simultaneously. Results were restricted by the physical limitations of the terrain used for the experiment. The data imply that too shallow a cut beneath the cliff bank might have restricted the vertical dimensions of the apparent crater. As charge burial depth was increased, horizontal apparent crater radius showed no significant change; vertical apparent crater radius became smaller as did crater depth below the charges; and crater volume decreased. A similar experiment could explore the possibilities of a second row of charges to strip additional overburden. The larger portion of the ejecta moved in the direction of the lower elevation, and the percentage moving in that direction increased with increased burial depth. About 9.9 cubic feet of ejecta per pound of explosive resulted from charges of equal burial depth and distance from face of cliff, almost 1.5 times the average of 6.4 cubic feet per pound of explosive from a previous experiment with charges in level ground. (auth)

8491 (UCRL–50008-66-1) PLOWSHARE PROGRAM. Vol. II, No. 2, October 1, 1965–July 15, 1966. Rabb, David (comp. and ed.) (Lawrence Radiation Lab., Univ. of California, Livermore). Contract W-7405-eng-48. 29p. Dep. mn. CFSTI $2.00 cy, $0.50 mn.

Significant progress is reported in isotope recovery, reentry through emplacement holes, equations of state of crushed rock, Panama Canal study, changes in rock permeability produced by Hardhat, venting mechanisms, comparison of nuclear and high-explosive detonations, and oil and gas reservoir engineering. Some field test results from Sedan, Handcar, Pre-Schooner II, Dugout, Gasbuggy, Ketch, Sloop, Bronco, Scroll, Sterling, Payette, Buggy, Cabriolet, and Flivver are given. (F.S.)

8492 (AWRE-Trans–54) SIMULATION OF LARGE-SCALE CRATERING EXPLOSION. Sadovskii, M. A.; Adushkin, V. V.; Rodionov, V. N. Translated by F. E. Wallwork (Atomic Weapons Research Establishment, Aldermaston, Eng.), from Dokl. Akad. Nauk SSSR, 167: 1253-5(1966). 7p. Dep. mn. BIS $0.30. HMSO 1s. 9d.

Formation of craters and the displacement of ejected rock were studied in a simulated cratering experiment conducted in an evacuated cylindrical chamber 500 mm in dia and 500 mm in length. A spherical air bubble enclosed in a thin rubber envelope was positioned in dry sand. The envelope was ruptured by a heated nichrome wire. Laboratory simulation results for the energy of the gas in the crater and velocity of rise of the ejected overburden were compared with results of the "Scooter" event. (F.S.)

8493 WARHEADS OF THE SURFACE-TO-AIR MISSILES. Roglic, S. Vazduhoplovni Glas., No. 2, 131-49(1966). (In Slovak).

The warheads of surface-to-air missiles such as cluster warheads and nuclear warheads, and their destructive capabilities are described. A detailed description of components such as the igniter, detonator, and high-explosive charge as well as description of the electric, radio command, radar, infrared, magnetic, and optical target-seeking and charge-activating systems, the safety and self-destruction devices is given. A separate chapter deals with nuclear and thermonuclear warheads. Technical and tactical characteristics, especially concerning the destruction radius, zone, isotropic and anisotropic effect of the high explosive warhead, and the shockwave, heat, and radiation effect of the nu-

clear warhead, are given. Nuclear explosives in the 0.25 to 10 kiloton range are considered. Block diagrams of explosive and nuclear warheads, their components, system arrangements, and various patterns of explosives are presented. (JPRS)

8494 PARTICLE MOTION NEAR A NUCLEAR DETONATION IN HALITE. Weart, Wendell D. (Sandia Corp., Albuquerque, N. Mex.). Bull. Seismol. Soc. Amer., 52: 981-1005 (Dec. 1962).

To determine the characteristics of earth motion parameters resulting from a nuclear explosion, measurements of acceleration, particle velocity, particle displacement, stress, and strain were made along a horizontal radius in the halite stratum where a nuclear device (Project Gnome) of nominal 5-Kt yield was detonated 360 m below the surface of the ground. The measurements extended from the zone of intense cracking and plastic flow (60 m) out into the elastic zone (480 m), accelerations being measured along a vertical radius. Travel time data from the horizontal radius revealed 3 distinct arrivals. First arrivals were propagated through the polyhalite layer with a velocity of 4.839 km/sec. This was followed by the direct elastic wave arrival in the salt horizon (4.318 km/sec) and the plastic wave which decreased in velocity as the stress level diminished. Vertically, the velocity varied from 5.1 km/sec at about 60 m above the shot to 0.785 km/sec a few meters below the surface. Peak accelerations in the salt were best fitted by the relations $A = 890\ R^{-5.3}$ from 60 to 122 m and $A = 560\ R^{-2.7}$ from 122 to 480 m. (R in hundreds of meters and A in units of gravity.) Peak particle velocity in the salt is given by $U = 13\ R^{-3.56}$ from 60 to 100 m and $U = 13\ R^{-1.36}$ from 100 to 480 m. Motion of the ground above the shot revealed that spalling occurred at several horizons. The deepest spall separation was below 92 m. These effects were most pronounced at the surface where the initial acceleration, velocity and displacement peak values were A = 25 g, U = 5.6 m/sec, and D = 168 cm. Residual upward displacement at surface zero at +5 min was 79 cm. (BBB)

Facilities and Equipment

Refer also to abstracts 8480, 9471, 9476, 9479, 9480, 9491, 9496, and 9519.

8495 (BAW-1280-40) SODIUM-HEATED STEAM GENERATOR DEVELOPMENT. Quarterly Progress Report, July-September 1966. (Babcock and Wilcox Co., Barberton, Ohio. Boiler Div.). Nov. 7, 1966. Contract AT(11-1)-1280. 12p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The preliminary design of a prototype sodium-heated steam generator for the Sodium-Reactor Development Program has been completed. Detail design is approximately 99% complete and fabrication of the prototype steam generator is approximately 75% complete. Fabrication has been delayed by labor and schedule interferences. The expected shipping date for the prototype steam generator is now February 28, 1967. (R.C.K.)

8496 (DP-1070) FIRE TEST AND THERMAL BEHAVIOR OF 15-TON LEAD-SHIELDED CASK. Wachtell, George Peter (Franklin Inst. Research Labs., Philadelphia, Pa.); Langhaar, John W. (Du Pont de Nemours (E. I.) and Co., Aiken, S. C. Savannah River Lab.). Oct. 1966. Contract AT(07-2)-1. 60p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

A 15-ton lead-shielded cask was subjected to a large, open-air petroleum fire. Experimental results were correlated by means of electric analog computation, using various assumed values for important parameters. The radiant absorptivity (α) of the cask was found both by this method and by hand calculations to be about 0.6 based on an effective fire temperature of 1800°F and an emissivity of unity, unity being appropriate in this case because of the method of measuring fire temperature. Although the cask was externally finned for convective cooling under normal operating conditions, α is calculated from the area of the outer shell excluding the fins. Convection of molten lead in the walls was found to be such that the horizontal temperature gradient in the molten lead was negligible. On the other hand, the vertical temperature gradient was about 8°F per inch of height, with some indication of a higher gradient in upward-facing walls than in sideward-facing walls. Fire tests of chrome-plated and unplated objects to determine extent of sooting effect on α were inconclusive because of destruction of the chrome plating. Test of a finned box half the size of the cask yielded a value of α essentially equal to that of the cask, indicating no size effect, and constant for the duration of the test, indicating no effect of sooting on α. Hand-calculation methods are presented for predicting the extent of melting as a function of time for lead-shielded casks of rectangular or cylindrical shape, for any selected fire conditions. Methods are also suggested for estimating the maximum cavity temperature in casks with either lead or nonmelting shielding. (auth)

8497 (MCW-1513) ELECTROLYTIC URANIUM PROJECT: CELL DESIGN. Terminal Progress Report. Vie, J. D. (Maryland Univ., College Park. Inst. for Molecular Physics). Sept. 30, 1966. Contract W-14-108-eng-8. 49p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

A preliminary design of a 40,000-ampere prototype uranium oxide-reduction electrolytic cell is described. This design is the culmination of the pilot plant work on the uranium electrolytic cell program at the Weldon Spring site. The cell design incorporates the experience gained from the successful operation of the following electrolytic cells: the 10,000-ampere pilot plant scrap-recovery cells; the 35,000-ampere prototype scrap-recovery cell, which was designed and built from information gathered from the 10,000-ampere cells. The prototype operated continuously for three months; the pilot plant 10,000-ampere uranium oxide-reduction cells, which were in operation for one and one-half years; and the three continuous oxide-reduction cells, which operated continuously for periods of five and six months. In addition to operating continuously for six-month periods, the oxide-reduction cells demonstrated the ability to produce reactor-grade metal in both static castings and centrifugally cast tubes and billets. The most recent two continuous oxide-reduction cell runs produced a total of 86,000 pounds of cast metal. Operation of an electrolytic cell with ^{235}U enrichments of 0.86% and 0.947% has been demonstrated. The prototype uranium oxide-reduction cell design is essentially a three-fold scale-up of the pilot plant continuous oxide-reduction cells with modifications designed to improve the temperature uniformity in the crucible. These modifications consist of a redesigned cathode collection system and the use of heat exchangers. (auth)

8498 (TID-23287) POTASSIUM CONDENSATE DROPLET SIZE DETERMINATION. Linhardt, Hans D. (Philco Corp., Newport Beach, Calif. Aeronutronic Div.). Aug. 1, 1966. Contract AT-(04-3)-595. 46p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The results of experimental determinations of potassium vapor condensate droplet sizes for typical thermodynamic expansion processes in the $1500°F < T < 1000°F$ temperature range and theoretical exhaust quality conditions $0.80 < x < 0.95$ are summarized. For this purpose, a forced convection, boiling-condensing, closed loop potassium facility was developed. The potassium loop provided the specified potassium vapor conditions to the test section which consisted of various expansion nozzles and nickel plated wedge specimens placed downstream of the nozzle. After performance of seven (four to five hours) short duration tests, the wedge erosion damage lengths were measured and correlated with two phase flow theory. The analysis of the test data provided internally consistent, accurate, and reproducible information on free stream droplet size as a function of theoretical vapor nozzle exhaust quality and saturation inlet temperature. The significant result is that the measured average free stream droplet size is of the order of 0.50 μ, which is an order of magnitude larger than the average droplet size predicted by present condensation theories. In addition, the exploratory program has proven that the selected nozzle-wedge erosion method works and, therefore, should be utilized for future more detailed two phase flow investigations. (auth)

8499 (TRG-Report-1273) MAINS-FREQUENCY INDUCTION HEATING OF HIGH-TEMPERATURE FLOWING SODIUM. Davidson, D. F.; Leece, J. (United Kingdom Atomic Energy Authority, Risley (England). Reactor Group). June 15, 1966. 22p. Dep. BIS $0.80. HMSO 4s. 0d.

Heating of flowing sodium in high-temperature experimental rigs has, in the past, presented problems of reliability of the heater and of the sodium containment. A method of mains-frequency induction heating is described, which can be designed to cover a large range of rig requirements and maintain accepted engineering standards for both the containment and the electrical equipment. The heater is in the form of a conventional power transformer except that the secondary winding is a single, short-circuited turn consisting of a stainless-steel pipe loop containing the sodium. With suitable lagging and cooling arrangements, the iron core and primary windings can be maintained at temperatures low enough for normal electrical insulating materials. A heater of this type has been made for the Fuel Element Thermal Test Rig at the Reactor Engineering Laboratory, Risley, and has performed very satisfactorily. A rating of 400 kW is obtained from two 200-kW, three-phase units. The system is designed for a sodium flow of 350 gal/min and an outlet temperature of 650°C. Designs have also been produced for 5-kW and 30-kW outputs. A method is described for determining the leakage reactance of a heater unit using a model pipe loop made from copper in place of the sodium-filled stainless-steel pipe loop. (auth)

8500 (Y-1561) MIXING AND SAMPLING ENRICHED ^{235}U FLUIDS IN CYLINDRICAL STORAGE CONTAINERS. Final Re-

port. Harrell, J. E. (Union Carbide Corp., Oak Ridge, Tenn. Y-12 Plant). Jan. 17, 1967. Contract W-7405-eng-26. 124p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

A study was performed that combined the measurement of some safe-tank mixing and sampling characteristics with a theoretical analysis for the generalization of mixing characteristics for recirculation in mixed-tank systems. Safe-tank mixing was simulated in an experimental facility that consisted of both horizontally and vertically oriented tankage that was equipped with flow-rate and fluid-concentration measurement components. Both single and parallel tanks were used. Fluid was mixed in the horizontal systems by recirculation and in the vertical tanks by air sparging. The mixing time required to disperse and mix a relatively small volume of tracer with the bulk fluid was measured. This mixing time was correlated with the flow rate. For single-tank systems, dispersion-intensity data were collected. Both mixing-time and dispersion-intensity data were found to fit reasonably well into a full logarithmic plot as a function of the recirculation rate by linear correlation. The theoretical treatment utilized a combination of the tanks-in-series model and the dispersion model, and required either analog or digital-computer solutions. For single-tank systems, a generalized and dimensionless solution for mixing-time prediction was obtained and plotted. A similar treatment was made for parallel-tank systems, but a solution to this complex problem cannot be presented as simply. However, an alternate scheme for predicting the upper limit of parallel-tank mixing time using the single-tank solution has been developed. Guidelines for mixing miscible fluids or mixing miscible fluids containing fine solids prior to representative sampling have been established. The effect of the piping arrangement of the various tankage systems upon mixing, sampling, and fuel-inventory uncertainties has been studied and recommendations made for the design and operation of a tankage system. (auth)

8501 CALCULATION OF INSTANTANEOUS COUNTING RATES IN THE MEASUREMENT OF SHORT-LIVED ISOTOPES. Marais, P. G.; Haasbroek, F. J. (Fruit and Food Tech. Research Inst., Stellenbosch, S. Afr.). S. Afr. J. Agr. Sci., 9: 479-82(1966).

When measuring short-lived isotopes, the counting period is frequently comparable to the half-life and in converting mean to instantaneous counting rates the radioactive decay of the sample must be taken into account. The effect of resolving time losses and this problem was investigated by Axton and Ryves. They simplified the calculations by taking the background as zero. An approximate formula was also proposed in which the mean observed counting rate is used for calculating resolving time losses. This necessitates an error term but it reduces to a simple expression for relatively short measuring times. The error term is extended for a more general applicability of the conversion formula, and it is shown that this formula can be simplified by making more valid assumptions instead of considering the background to be zero. It was also shown that it is an advantage to calculate the instantaneous counting rate for the middle of the measuring time rather than the initial value as was done by Axton and Ryves. (BBB)

8502 HOW LONG WILL OUR ENERGY SOURCES LAST? Rydberg, Jan. (Chalmers Tekniska Hoegskola, Goeteborg, Sweden). Svensk. Kem. Tidskr., 78: 456-69(1966). (In Swedish).

Extensive data are compiled and are tabulated which enabled a prediction of energy consumption to year 2050. This estimate is based on the increase in population, per capita consumption, and efficiency of transforming resources into useful energy forms. Estimated consumption is compared to known and estimated reserves of water power, oil, gas, coal, and the nuclear fuels uranium and thorium. The conclusion is reached that at year 2000 most oil and gas reserves will have been used up, and that the installation and demand of nuclear power will greatly exceed what is today normally expected. By 2050 most uranium and thorium reserves will be used up or in use, so that the need for fusion power is imminent. Topics also considered include the steps in processing and generating various types of nuclear fuel, different types of nuclear power reactors, and a compilation of present or planned nuclear power generating installations in various nations. (BBB)

8503 A VERSATILE, INEXPENSIVE NEUTRON HOWITZER. Rawls, W. S.; Voss, H. G. (Arizona State Univ., Tempe). Amer. J. Phys., 34: 1182-4(Dec. 1966).

A neutron howitzer was constructed using readily available materials and commonly used tools. The neutron howitzer is versatile, of quality construction, safe for student use, and low in cost. (auth)

8504 DIRECT CYCLE HEAVY WATER TURBINE FOR "MARVIKEN." Nucl. Eng., 12: 33(Jan. 1967).

The design of the turbine for this first direct cycle heavy water system is described. Although designed for use with superheated vapour, it must be compatible with saturated vapour conditions for up to three years during development. The steam condition specifications are superheated — 594 psi, 475°C(198 MW(e)), and saturated — 681 psi, 260°C(138 MW(e)). (UK)

8505 HYDRAULICS PRODUCE RADIATION BURSTS. Pollak, Kurt (Baldwin-Lima-Hamilton Corp., Eddystone, Pa.). Hydraul. Pneum., 19: 104-8(Nov. 1966).

Techniques and equipment are described by which acceleration and deceleration of large uranium masses are controlled hydraulically with a high degree of accuracy and a wide range of adjustability. Control is maintained from a bunker ½ mile from the machine. A 3000-psi piston pump, supplied by an overhead temperature-controlled tank, provides the power. The pump, in a machinery room above ground, feeds the atomic device in an air-conditioned silo 100 ft below ground. Television cameras, transducers, and strain gages monitor all functions. The scram system is actuated by a double-acting, nitrogen-oil cylinder; it moves one U mass 0.3 in. in 0.013 sec from receipt of signal. The piston has a snubber for soft deceleration in the last 5 in. of the downward stroke. The rod side of the cylinder is precharged with 1300 psi of nitrogen. This pressure is raised by the upward stroke of the piston and acts as the energy storage necessary to produce the scram acceleration. The head end of this cylinder receives 9 radially arranged, specially designed, 1-in. scram valves. As the U masses assemble, neutron generation increases and at a preset level signals for scram; all scram valves open. The scram cylinder piston moves down rapidly, followed by the one U cylinder. An important safety feature was included in the design of the scram valve: should the neutron generated signal for scram fail, the thermal shock experienced in the U masses will result in material expansion, intensify the oil column under piston for the U mass and open the scram valves. To make sure this operates, the magnet holding current is tailored to the valve opening forces so that once the oil forces the armature pin gap to increase slightly, it has no power to close the pilot and the valve remains open. (BBB)

8506 HIGH SPECIFIC IMPULSE THRUST BY SPUTTER-EJECTION OF NEUTRAL ATOMS. Meckel, Ben B. (Physics Technology Lab., La Mesa, Calif.). Astronaut. Acta, 12: 199-206(May-June 1966).

The unique characteristics of atom ejection from single crystals as a result of ion bombardment were investigated. High specific impulses at low thrust are possible and the method appears useful for space propulsion applications. It has been found that controlled sputtering can be used to eject a dense beam of neutral atoms (equivalent currents of several hundred milliamperes per square centimeter) at high average velocities (0.5 to 5×10^6 cm/sec) in a preferred direction. A review of past research shows that the mechanism of sputtering is a momentum transfer process in which incoming ions transfer their energy to the lattice atoms and subsequent collisions may result in ejection of atoms from the surface. The focusing and chaining of energy along lines of atoms in a crystal result in high energy, preferentially directed ejections. Preliminary experimental measurements of force and mass flow produced by sputtered atoms have been made under dynamic conditions. Forces of 4.5 dynes/ma at 2,300 sec specific impulse were obtained with Ar^+ ion bombardment of Cu. Energy conversion efficiencies of electric power to thrust were found to be as high at 50%. The utilization of critical sputtering parameters is shown to be an efficient and practical method of converting electrical energy to thrust. A sputter-ejection "solid fuel" thrust device would eliminate the neutralization problem, erosion problems, and fill an important specific impulse gap. (auth)

8507 EXTRUDER DIE, 120 TON (Engineering Materials). (California Univ., Livermore. Lawrence Radiation Lab.). (CAPE-1520).

10 drawings.

An extruder die is described. The die is used in extruding various combinations of sizes of ceramic reactor tubes. Mandrels and diameter inserts are tabulated for different size combinations. The die is used with a 120 ton extruder. (For details see TID-4100 Suppl. 38.) (F.S.)

8508 FILTER HOLDERS (Engineering Materials). (Du Pont de Nemours (E. I.) and Co., Aiken, S. C. Savannah River Lab.). (CAPE-1505).

2 drawings.

Two filter holders used in testing filter materials in a 6 in. dia deionized H_2O column at 25°C are described. The 6 in. filter holder is fabricated from plexiglass. The 4⅞ in. holder is fabricated from Al. The filter media were tested to determine filter effi-

ciency for moisture separators and particulate filters. (For details see TID-4100 Suppl. 37.) (F.S.)

8509 ZINC BROMIDE RADIATION-SHIELDING WINDOW MAINTAINED UNDER AN INERT GAS ATMOSPHERE. Lane, Williams B. (to Dept. of Navy). U. S. Patent 3,286,095. Nov. 15, 1966. Filed Sept. 30, 1963.

An improved zinc bromide radiation shielding window which maintains its optical transparency is described. Chemically induced contamination which causes discoloration of the zinc bromide solution is controlled by placing metal surfaces which are exposed to the solution under an inert gas atmosphere. The inert gas used is a compound of argon. An expansion tank for the zinc bromide solution is provided with a means for covering the solution with argon. (F.S.)

8510 NUCLEAR IRRADIATION INSTALLATION. Balla, Imre; Eliahu, Yad (to The State of Israel, Ministry of Defence). U. S. Patent 3,284,306. Nov. 8, 1966. Priority date Mar. 24, 1963, Israel.

An irradiation facility for neutron irradiation of small samples in a reactor is described. The facility consists of a receiving station and a processing station located in the vicinity of the reactor core, conveyor ducts communicating with the stations, a pneumatic system, valves, and spherical containers to hold samples to be irradiated. (F.S.)

8511 REMOTE CONTROL MANIPULATORS. Biggley, William H.; Culshaw, Ronald C.; Biggley, Betty Anne (to Atomic Energy of Canada Ltd.). U. S. Patent 3,282,442. Nov. 1, 1966. Filed June 23, 1964.

A remotely controlled manipulator is described which consists of master and slave units and an interconnection such that any movement applied to the master unit is automatically followed by the slave. A twist motion about a first axis, a wrist motion about a second axis, a reach motion, an elbow motion, and an azimuth rotation motion of the entire slave unit are provided. (F.S.)

8512 MECHANICAL COUPLING DEVICE, ESPECIALLY FOR PRESSURE VESSELS. Leclou, Andre (to Commissariat a l'Energie Atomique). U. S. Patent 3,275,181. Sept. 27, 1966. Priority date July 24, 1962, France.

A coupling device to mechanically couple two components of a pressure vessel having a general axis of symmetry is described. The coupling device substantially reduces the displacement of the anchoring efforts relative to the wall of the vessel. Forces tending to separate the two components are resisted by a simple and sturdy device employing mechanical force transfer. (F.S.)

Heat Transfer and Fluid Flow

Refer also to abstract 10213.

8513 (NASA-TN-D-3771) DESIGN STUDY OF A REGENERATIVELY COOLED NOZZLE FOR A TUNGSTEN WATER-MODERATED NUCLEAR ROCKET SYSTEM. Puthoff, Richard L. (National Aeronautics and Space Administration, Cleveland, Ohio. Lewis Research Center). Dec. 1966. 34p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

A regeneratively cooled nozzle was used for the tungsten water-moderated nuclear rocket (TWMR). The walls of the nozzle were cooled by hydrogen which was then used in the rocket system heat exchanger and topping turbine. A computer calculated a heat balance at predetermined stations along the nozzle axis. These calculations were summed over the entire nozzle length providing an integrated nozzle coolant pressure drop and temperature increase. To meet the design requirements set forth for the TWMR nozzle, a parametric study was conducted. In the case of nozzle parameters such as coolant tube areas, tube thicknesses, and number of coolant tubes, the effects of varying these parameters were felt most significantly by the nozzle ΔP_c (coolant pressure drop) with little effect on the ΔT_c (coolant temperature increase). Only when decreasing the inlet angle of the nozzle convergent section could a significant change in ΔT_c be effected. The tube stresses were also examined to determine the effect when varying these parameters. The design selected was designated the TWMR reference design. At 100 percent rocket power, the reference design nozzle coolant pressure drop is 132.3 pounds per square inch, coolant temperature increase 119.2°R, and a maximum tube wall temperature of 1820°R. Nozzle performance calculations were also made at rocket reduced power conditions. Although the nozzle design presented is unique to the TWMR rocket engine, the principles involved are applicable to other nuclear rocket designs. (auth)

8514 (SC-CR-66-2124) METHODS FOR ANALYZING SPECTRAL AND DIRECTIONAL EFFECTS IN RADIATIVE HEAT TRANSFER, AND EXPERIMENTAL MEASUREMENTS OF HEAT TRANSFER FROM RADIATING EXTENDED SURFACES. Treat, C. H.; Wildin, M. W. (New Mexico Univ., Albuquerque. Bureau of Engineering Research). Oct. 1966. Contract AT(29-1)-789. 72p. (ME-24). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

For Sandia Corp., Albuquerque, N. Mex.

Techniques for treating radiant heat transfer between bodies whose thermo-optical properties are functions of frequency and direction are discussed. Since techniques for treating frequency-dependent properties are fairly well established, approximate methods which have been advanced for dealing with direction-dependent properties are described. It is shown that the more accurate approximations require much data for the thermo-optical properties and the simultaneous solution of large numbers of linear algebraic equations. The modeling technique which is used to obtain experimental results for comparison with the analytical results published for one configuration of radiating extended surfaces and the design and assembly of a model are described. Some of the experimental and analytical results are presented and discussed. (auth)

8515 (SC-DC-66-2365) HEAT TRANSFER AND TEMPERATURE DISTRIBUTION IN FINNED RADIATORS. Wildin, Maurice W. (New Mexico Univ., Albuquerque. Bureau of Engineering Research). Aug. 1965. Contract AT(29-1)-789. 74p. (ME-15). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

For Sandia Corp., Albuquerque, N. Mex.

A mathematical analysis of heat transfer and temperature distribution in infinite finned radiators separated by nonparticipating media is presented. The relations between properties are defined. The formulation of the problem and method of solution are discussed. Results were calculated by computer and tabulated for two materials, roughened 6061-0 aluminum and fused silica. A comparison of the numerical results with the results of previous investigators is given. (L.C.L.)

8516 (SC-DC-66-2366) TEMPERATURE AND STRESS DISTRIBUTIONS PRODUCED IN LONG CIRCULAR CYLINDERS COOLED BY EMISSION OF THERMAL RADIATION. Final Report. Pritchard, Robert S.; Wildin, Maurice W. (New Mexico Univ., Albuquerque. Bureau of Engineering Research). Nov. 1965. Contract AT(29-1)-789. 116p. (ME-19). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Thesis. Submitted by Robert S. Pritchard.

For Sandia Corp., Albuquerque, N. Mex.

The temperature and stress distributions produced in long circumferentially symmetric circular cylinders cooled by emission of thermal radiation from the lateral surface were studied. Temperature and strain responses obtained from an experimental model are presented for a set of parameters which correspond to the highest strain level which could be accurately determined with the strain gages. Temperature responses obtained from the same model, but having a higher initial temperature, are also presented. Both responses were compared with analytical results. Reasonably good agreement between experimental and theoretical results was obtained for these sets of parameters. To specify parameters in the mathematical model, certain material properties were needed. Testing to determine thermal conductivity using a transient technique is described. The lateral surface of the model was coated with Krylon Flat Black Spray Enamel to increase the cooling rates, and the stress levels obtained. Testing to determine the value of total hemispherical emittance is also described. Testing to determine gage factor and false strain was performed to determine these characteristics when the strain gages were embedded in the modeling material. (auth)

8517 (SC-RR-66-577) PAD-ABORT THERMAL FLUX MODEL FOR LIQUID ROCKET PROPELLANTS. Kite, F. D.; Bader, B. E. (Sandia Corp., Albuquerque, N. Mex.). Nov. 1966. Contract AT(29-1)-789. 17p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

A model of the thermal environment resulting from the on-pad abort of a liquid propellant launch vehicle is presented. (auth)

8518 BOILING-LIKE PHENOMENA AT SUPERCRITICAL PRESSURES. Nishikawa, Kaneyasu (Kyushu Univ., Japan); Miyabe, Kiyoji. Mem. Fac. Eng., Kyushu Univ., 25: No. 1, 1-25 (Dec. 1965).

The problem of heat transfer to fluids near the critical pressure has arisen because of the industrial need for supercritical pressure boilers, cooling of rocket motors and gas turbine blades, and heat removal from nuclear reactors. A study was made to elucidate the heat transfer mechanism of a supercritical fluid. With the experimental apparatus of free convection, the boiling-like phenomenon was examined by photographic observation and heat transfer coefficient measurement. For the heating surface a platinum wire was used, and carbon dioxide as the test fluid. To study an abnormal convection in the supercritical pressure region, an experiment of free convection was made by Goldmann's boiling-like

theory. For this abnormal convection at supercritical pressure, two phenomena are considered, which are nucleate boiling-like and film boiling-like phenomenon. In this case, with the appropriate models of a two-phase fluid, the heat transfer characteristics of the normal convection, boiling as well as abnormal convection can be explained by the general law. The abnormal convection tends to occur when the pseudocritical temperature is interposed between the heating surface and the fluid, but at a supercritical pressure at which the difference from the critical pressure is large, no abnormal convection occurs even under this condition. Under what conditions the boiling-like phenomenon occurs must further be studied in the future. (NSA of Japan)

8519 EFFECT OF ORIFICE PRESSURE DROP ON BURNOUT HEAT FLUX IN PARALLEL CHANNELS. Hori, Masao; Ouchi, Yoshihiro (Japan Atomic Energy Research Inst., Tokyo). Nippon Genshiryoku Gakkaishi, 8: 536-9(Oct. 1966). (In Japanese).

As exemplified in the case of boiling water reactors, orificing at the inlet of each channel is considered to be effective in suppressing flow instability in parallel channels. It is also expected that such orificing should affect the burnout heat flux in parallel channels. The burnout heat flux in parallel channels was measured by varying the single phase (orifice) pressure drop and other conditions (flow rate and inlet temperature) in atmospheric pressure. It was found as a result that burnout heat flux generally becomes higher as the single phase pressure drop is increased under fixed conditions of flow rate and inlet temperature. In one case however, the burnout heat flux became higher with decreasing single phase pressure drop. This was probably due to the large effect of natural circulation caused by the low flow rate of that particular case. (NSA of Japan)

8520 HEAT TRANSFER IN LAMINAR FLOW WITH INTERNAL HEAT GENERATION IN CONCENTRIC ANNULUS. Michiyoshi, Itaru (Kyoto Univ.). J. Nucl. Sci. Technol. (Tokyo), 3: 479-85(Nov. 1966).

An analysis of heat transfer in laminar flow with uniform internal heat generation in a concentric annulus with uniform but different heat fluxes at the two wall surfaces is described. The Nusselt numbers at each wall surface are calculated upon analyzing the radial distribution of the fluid temperature. Results show that the Nusselt numbers are affected by the ratios of the radii as well as of the wall heat fluxes, and also by the internal heat generation. As a special case, the analytical results of heat transfer in the absence of internal heat generation are compared with Dwyer's and Lundberg, et al.'s theories. (auth)

8521 BOUNDARY-LAYER ION DENSITY PROFILES AS MEASURED BY ELECTROSTATIC PROBES. Bredfeldt, H. R.; Scharfman, W. E.; Guthart, H.; Morita, T. (Stanford Research Inst., Menlo Park, Calif.). AIAA (Amer. Inst. Aeronaut. Astronaut.) J., 5: 91-8(Jan. 1967).

Ion-density profiles in boundary layers associated with supersonic flow of shock-heated air over a flat plate have been measured by cylindrical and flush-mounted electrostatic probes. A method of cylindrical-probe data interpretation presented accounts for the effects of a plasma drift velocity. An appropriate method for flush-probe interpretation also is given. The experiments were carried out in a pressure-driven shock tube at 0.1 torr initial shock tube pressure, and ranged over five orders of magnitude in freestream charge density from 10^9 ions/cm^3 to 10^{14} ions/cm^3. The experimental profiles were compared to theoretical profiles derived on the basis of a zero-order boundary-layer theory, assuming frozen flow. Good agreement with the zero-order theory is obtained below 10^{12} ions/cm^3. Above 10^{12} ions/cm^3, experimental evidence indicates that the boundary layer begins to depart from the theoretical assumption of frozen flow. (auth)

8522 DETERMINATION OF THE STEADY TEMPERATURE DISTRIBUTION IN SOLIDS WITH INTERNAL HEAT SOURCES AND TEMPERATURE-DEPENDENT THERMAL CONDUCTIVITY. Pfann, Jaroslav (Nuclear Research Inst., Rez, Czech.). Nucl. Eng. Design, 4: 121-8(Aug. 1966).

The determination of the steady temperature distribution in solids with internal heat sources in the case when the thermal conductivity varies with the temperature is described. Formulas are presented which express explicitly the temperature for several elementary types of temperature dependence of thermal conductivity. Relations are given which reduce the solution of the differential equation for a one-dimensional problem to a mere double integration. The proposed method is applied to several examples. (auth)

8523 HEAT TRANSFER AND FRICTION FOR LAMINAR FLOW OF HELIUM AND CARBON DIOXIDE IN A CIRCULAR TUBE AT HIGH HEATING RATE. Worsoee-Schmidt, P. M. (Technical Univ. of Denmark, Copenhagen). Contract AT(04-3)-247. Int. J. Heat Mass Transfer, 9: 1291-5(Nov. 1966).

Using an implicit finite-difference scheme, solutions were worked out for hydrodynamically developed laminar flow of helium and carbon dioxide with uniform heating rates so high that appreciable variations of gas properties occur. Whereas the results for helium closely approximated those previously found for air, both the Nusselt numbers and the friction factors for carbon dioxide come out considerably higher. For the Nusselt number with pure forced convection improved empirical expressions, based on the local Graetz number, are given. The local friction factors can be estimated from the wall-to-bulk temperature ratio. (auth)

8524 NONUNIFORM HEAT FLUX BURNOUT IN VERTICAL CIRCULAR TUBES WITH UPWARD WATER FLOW. Smith, Olin Glenn. Pittsburgh, Univ. of Pittsburgh, 1965. 104p.

Thesis.

The question of whether burnout can be predicted from local parameters at the burnout location or whether it depends on inlet enthalpy and axial heat flux distribution was resolved experimentally. Furthermore, the implicit effect of inlet enthalpy and axial heat flux distribution upon the burnout heat flux in circular tubes was evaluated quantitatively. Both uniform and non-uniform heat flux burnout tests were performed with subcooled inlet and net steam quality at burnout. Ranges of parameters tested were: pressure, 515 psia; burnout quality, 0.2 to 0.8; burnout heat flux, 1.2×10^6 to 2.2×10^6 Btu/hr-ft^2; and mass flow rate, 0.55×10^6 and 1.10×10^6 lb/hr-ft^2. An analysis was performed considering an annular flow pattern and a simplified rate equation for liquid transfer to the film. A concise expression for evaluating the implicit effect of axially nonuniform heating upon the burnout heat flux was developed. (Dissertation Abstr.)

8525 PROCESS AND APPARATUS FOR IMPROVING THE TRANSFER OF HEAT FROM A HOT GASEOUS FLUID. Huyghe, Jean; Mondin, Henri (to Commissariat a l'Energie Atomique). U. S. Patent 3,274,752. Sept. 27, 1966. Priority date Feb. 13, 1962, France.

An improved heat exchanger and a method for improving the transfer of heat from one fluid to another when the cooling fluid is liquid or gaseous and the fluid giving up the heat is gaseous are described. The heat exchanger has a means for introducing droplets of an auxiliary liquid which will not vaporize at temperatures in the heat exchanger. The droplets mix and form a film on the internal wall of the exchanger tubes which prevent vaporization and improve heat transfer. Means are provided for removing the auxiliary liquid after it passes through the exchanger and preparing it for recirculation. (F.S.)

Isotope Technology

8526 (ORNL-3905) ISOSEARCH; COMPUTER PROGRAM FOR CALCULATING UNKNOWN VARIABLES IN REACTION AND DECAY SCHEMES. Friend, C. W.; Lewis, R. E.; Jenkins, A. R. (Oak Ridge National Lab., Tenn.). Jan. 1967. Contract W-7405-eng-26. 28p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Program ISOSEARCH was developed in order to calculate an unknown reaction cross section, flux value, or product activity in an isotope-production scheme consisting of two or three nuclides. A searching method is employed in the program which starts with maximum and minimum estimates (supplied in the input data) and converges to a value that fits the input data. The basic theory and use of ISOSEARCH are explained, and sample problems and the FORTRAN calling program are included in the report. (auth)

8527 (ORNL-TM-1505(Pt.3)) SELECTED ABSTRACTS OF NON-U.S. LITERATURE ON PRODUCTION AND INDUSTRIAL USES OF RADIOISOTOPES. From NSA July-September 1966. Gerrard, Martha; Baker, P. S.; Lafferty, Robert H. Jr. (Oak Ridge National Lab., Tenn.). Dec. 1966. Contract W-7405-eng-26. 47p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

More than 350 abstracts of non-U. S. publications on production and use of radioisotopes and radiation, selected from the July-September 1966 issues of Nuclear Science Abstracts, are presented. (auth)

8528 (TID-23474) INDUSTRY'S EVALUATION OF ISOTOPES AND RADIATION. Currie, Lauchlin M.; Bizzell, Oscar M. (Division of Isotopes Development (AEC), Washington, D. C.). Apr. 19, 1965. 14p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

A survey was made of forty companies to determine the extent of industrial development of isotopes and radiation. A statistical summary of the present status of isotope development in these companies is given. Recommendations which would stimulate industry's use of radioisotopes are made. (L.C.L.)

8529 (AEC-tr-6641, pp 157-69) GAMMA-BACKGROUND OF THE SEA. Samokhin, G. V.; Fedorov, A. F. Translated

from Radioaktivnaya Zagryaznennost' Morei i Okeanov, Izdatel' stvo Nauka, Moscow, 1964.

The intensity of γ radiation in the regions of the northern fishing basin was examined. The lowest γ background was found in the open sea. In the near shore regions, a constant γ background was found except during spring. The γ intensity in the regions directly adjacent to the coastal zone depends on the nature of the region. An increase in γ background was observed during precipitation. Background diminished with depth due to water screening of the cosmic component. There was an increase in γ intensity in water adjacent to the bottom due to the γ radiation of the sea floor. (F.S.)

8530 (AEC-tr-6641, pp 53-8) ARTIFICIAL RADIOACTIVITY OF THE OCEANS. Sereda, G. A. Translated from Radioaktivnaya Zagryaznennost' Morei i Okeanov, Izdatel'stvo Nauka, Moscow, 1964.

The largest source of contamination of the oceans by artificial radioactivity is from nuclear weapons testing. Of all the radioisotopes from nuclear explosions only ^{90}Sr and ^{137}Cs have remained in considerable quantities in the dissolved state. Vertical exchange of water below the layer of temperature discontinuity causes migration of ^{90}Sr and ^{137}Cs to depths of 1000 m over a period of 3 to 4 yr. Quantities of ^{90}Sr and ^{137}Cs throughout the ocean are several times greater than the corresponding quantities for dry land. The amounts of cesium and strontium in the oceans cannot be estimated from radioactivity determinations in soils. (F.S.)

8531 ESTIMATION OF ^{90}Sr AND ^{137}Cs CONTENT IN THE BLACK SEA. Belyaev, L. I.; Gedeonov, L. I.; Yakovleva, G. V. Okeanologiya, 6: 641-4(1966). (In Russian).

Based on studies of radioactive fallout over the Black Sea during the period 1959 to 1964, an attempt was made to estimate the ^{90}Sr and ^{137}Cs content of the Black Sea. In calculating the content, it is assumed that the fallout density over the Black Sea is proportional to the rainfall. In determining the radioactive content, radiation carried to the Black Sea by its tributaries, isotope decay, and water exchange between the Black, Azov, and Marmora Seas is taken into account. Tables are presented which show the total fission product fallout over the Black Sea for 1960 to 1964, the water balance of the Black Sea, ^{90}Sr influx into the Black Sea, ^{90}Sr efflux into the Seas of Marmora and Azov, and the ^{90}Sr balance in the Black Sea. Since there is no available data on ^{137}Cs concentration in the Black Sea tributaries, this estimate was made assuming that the activity ratio of ^{90}Sr to ^{137}Cs is 2 to 1. By the end of 1964, the estimated ^{90}Sr and ^{137}Cs contents of the Black Sea were 2.7×10^4 and 5.4×10^4 Ci, respectively. (ATD)

8532 RADIOACTIVE MEASUREMENT TECHNIQUES FOR THE WEIGHT OF SURFACES. PART II. Kosbahn, Thomas (Arolsen, Kreis Waldeck, Ger.). Arch. Tech. Messen, No. 368, 193-8(Sept. 1966). (In German).

The use of the β radiator is described in terms of the choice of source radiation detector, effects of the geometric arrangement of source and detector, technological applications and procedures, and backscatter procedures. Theoretical and practical descriptions are given of equipment and procedures of an ionization chamber for thickness measurement, comparison of the numbers of ion pairs for α and β radiation as a function of voltage, schematic diagram of a radiation densitometer, principle of a compensating circuit with two ionization chambers, commercial source-detector equipment, equipment compensated for continuous measurement of thickness of plastic tubes or pipes with β radiation, arrangement of an ionization chamber for measurement of backscattered β radiation used for measurement of thickness of rubber sheeting with thickness d on a steel drum of thickness D, and the backscatter energy as a function of the steel drum thickness and rubber sheeting thickness. The saturation thickness is reached with the steel drum, but the rubber sheeting must be measured below its saturation value. (BBB)

8533 RADIOACTIVE MEASUREMENT TECHNIQUES FOR WEIGHT OF SURFACES. PART III. Kosbahn, Thomas (Arolsen, Kreis Waldeck, Ger.). Arch. Tech. Messen, No. 369, 217-20 (Oct. 1966). (In German).

The nature of bremsstrahlung is discussed. The dependence of the bremsstrahlung spectrum on the thickness of an irradiated Pb target is illustrated by spectra for ^{147}Pm, ^{85}Kr, and $^{90}Sr/^{90}Y$ sources and different thicknesses of target. The absorption curve for bremsstrahlung from $^{90}Sr/^{90}Y$ through steel is shown to be a sensitive measure of thickness. Illustration and discussion of available devices for application of bremsstrahlung are given. The nature of γ radiation is discussed. Linear diminution coefficients of γ rays in Pb as a function of radiation energy are given, and the coefficients are divided into the photoeffect, Compton effect, and pair production components. The mass diminution coefficients are also given and similarly divided. A table of γ emitters for surface mass measurements is given, including pertinent properties of ^{170}Tm, ^{75}Se, ^{192}Ir, $^{137}Cs/^{137}Ba$, ^{182}Ta, ^{60}Co, and ^{226}Ra. (BBB)

8534 RADIATION-HARDENED WOOD-PLASTIC COMBINATIONS. Guetlbauer, F.; Proksch, E.; Bildstein, H. (Institut fuer Chemie, Reaktorzentrum, Seibersdorf, Austria). Oesterr. Chem.-Ziet., 67: 349-61(1966). (In German).

Products obtained by impregnation of wood with various vinyl monomers and subsequent polymerization with high-energy radiation have the aesthetic appearance of wood as well as greater strength and water resistivity. Methods of preparation, properties, costs, and possible uses are described. Fifteen types of wood are suggested for use, and the relation of the monomers vinyl chloride, methyl methacrylate, vinyl acetate, and styrene-acrylonitrile to the preparation of combinations from 11 of these is tabulated. Typical doses for complete polymerization in an inert gas for 7 combinations of wood and monomer are given, together with description of sources and activators. Industrial layouts are reviewed briefly, and hardness, strength, and special properties of the products are described. Use of the materials for construction elements, furniture, sports equipment, and other applications is outlined. New results for a spruce wood–methyl methacrylate combination are given; % polymerization, hardness, and strength are shown graphically as functions of the dose. (BBB)

8535 METHODS FOR CALCULATING OPTIMALLY OPERATING THERMAL DIFFUSION COLUMNS. Dickel, G.; Troetsch, E. (Univ., Munich). Isotopenpraxis, 2: 429-32(Nov. 1966). (In German).

The time-expensive calculations for optimally operating thermal diffusion cascades may be avoided when one treats the problem from the general point of view by calculus of variations. The Hamiltonian characteristic function of the variation problem appears as the value function of Cohen, which is a direct measure of minimum energy expenditure in the separation process. Finally, the consequent development of the theory allows the determination of the family of all optimally operated thermal diffusion cascades in a simple manner. Moreover, the problem of square cascades may be solved with the aid of this method. (auth)

8536 HEAVY ION IDENTIFICATION USING THE POWER LAW TECHNIQUE. Cerny, J.; Cosper, S. W.; Butler, G. W.; Brunnader, H.; McGrath, R. L.; Goulding, F. S. (Univ. of California, Berkeley). Contract W-7405-eng-48. Nucl. Instrum. Methods, 45: 337-9(Dec. 1966). (UCRL-17101).

Preliminary measurements are reported on the separation of isotopes of beryllium, boson, and carbon using a power law type of particle identifier described previously by F. S. Goulding et al. (Nucl. Instr. and Meth. 31(1964)1). (B.G.D.)

8537 RATIO OF DISPERSION TO MAGNIFICATION IN MAGNETIC MASS SPECTROMETERS. Chavet, I. (Atomic Energy Commission, Tel-Aviv, Israel). Nucl. Instrum. Methods, 45: 340 (Dec. 1966).

The ratio of dispersion to magnification is investigated since it is an important factor for the determination of the resolving power of magnetic mass spectrometers or of the enrichment factor in electromagnetic isotope separators. (B.G.D.)

8538 RADIOISOTOPE-POWERED NAVIGATION LIGHT. Elec. Export Rev., 5: 112(Oct.-Dec. 1966).

A description of the U. K. Atomic Energy Authority-designed milliwatt isotope-powered generator for use in marine navigation is given. Called RIPPLE II (Radioisotope Powered Pulse Light Equipment) it is intended to power a standard marine navigation light employing a Xe flash tube to give a light visible at a range of 2 miles. It provides power for a 0.2-J flash every $3\frac{1}{2}$ sec but could be designed for any flash frequency or for applications requiring power pulses 50 times greater without exceeding 2 to 3 W mean power output rating. Models of this equipment are now being tested by various navigational bodies. The heat source in Ripple II is ^{90}Sr encapsulated in stainless steel. It is made up in the form of $SrTiO_3$, which has the advantage of being insoluble in seawater, and has an activity of 700 Ci. Strontium-90's half life of 28 yr makes a 10-yr design lifetime feasible for the generator. The generators consist of an array of B_2Te_3 thermocouples each made up on a pair of bismuth-telluride-doped P and N semiconductors. These are connected in series and so arranged that heat from the source flows through each couple in parallel and into the cold sink. A compact array of thermocouple pairs has been developed which produces about 70 mW at 400 mV. A tunnel diode converter converts this output to a 6-V 30 mW dc supply for charging the storage cells. (BBB)

8539 RADIOISOTOPES FOR AEROSPACE. PART 1. ADVANCES AND TECHNIQUES. Proceedings of the First Symposium held in Dayton, Ohio, February 15–17, 1966. Dempsey, John C.; Polishuk, Paul (eds.). New York, Plenum Press, 1966. 464p. $20.00. (CONF-660207–).

Abstracts of fifteen papers are included. Abstracts of twelve papers have appeared previously in NSA. See CONF-660207 in the Report Number Index for these papers. (R.C.K.)

For abstracts of individual papers see: 8540–8549, 8555–8558, and 8587.

8540 APPLICATIONS OF RADIOISOTOPES IN FLIGHT DYNAMICS. Stalder, J. R. (Air Force Flight Dynamics Lab., Wright-Patterson AFB, Ohio). pp xxiii-xxx of Radioisotopes for Aerospace. Part I. Dempsey, John C.; Polishuk, Paul (eds.). New York, Plenum Press, 1966.

The uses of radioisotopes in aerospace applications are presented. The present state of the art and the future potential of radioisotope technology are discussed. Examples of current applications and their limitations are given. The need for quality control, smaller size, safety, and lower cost is pointed out. (L.C.L.)

8541 ISOTOPES INFORMATION CENTER. Baker, P. S. (Oak Ridge National Lab., Tenn.). pp 118-22 of Radioisotopes for Aerospace. Part I. Dempsey, John C.; Polishuk, Paul (eds.). New York, Plenum Press, 1966.

The scope, method of operation, and uses of the Isotope Information Center at ORNL are described. The center contains complete copies of the literature dealing with the production and use of isotopes. The documents are microfiched and are indexed for information retrieval using the Termatrex system. The Center serves to answer isotope information inquiries and to publish reviews and evaluations of developments in isotope technology. (L.C.L.)

8542 INDUSTRIAL AND FEDERAL APPLICATION OF RADIOISOTOPES. Bossen, D. A. (Industrial Nucleonics Corp., Columbus, Ohio). pp 123-42 of Radioisotopes for Aerospace. Part I. Dempsey, John C.; Polishuk, Paul (eds.). New York, Plenum Press, 1966.

A survey of the uses of radioisotope techniques in industry and Federal Agencies is given. Many examples of industrial process control applications with fixed-position radiation sources and detectors are described and illustrated. Applications of variable-positioned sources and detectors for aircraft guidance systems are explained. The 100% safety record of radioisotope gaging devices is emphasized. (L.C.L.)

8543 APPLICATION OF KRYPTONATE SOURCES TO AEROSPACE USE. Chleck, David (Parametrics, Inc., Waltham, Mass.). pp 183-98 of Radioisotopes for Aerospace. Part I. Dempsey, John C.; Polishuk, Paul (eds.). New York, Plenum Press, 1966.

The concept of a new type of radioactive source called kryptonates is discussed. Kryptonates are defined as any solid material into which the inert gas krypton-85 has been incorporated. Krypton-85 can be incorporated into any solid material thereby converting krypton-85 into a universal tracer. Two general methods of preparation and the resultant properties of these materials are outlined. Typical aerospace uses of these sources include: temperature profile measurements in engine turbine blades, hazardous or toxic gas analyses, oxidation and corrosion studies, and friction and wear determinations. Potential industrial applications of kryptonates, e.g., sensitive chemical analyzers for both gases and solutions, the study of high-temperature corrosive reactions, the measurement of surface and interfacial temperatures, and the simultaneous study of major factors controlling friction and wear, are presented. (L.C.L.)

8544 ISOTOPIC NEUTRON SOURCES. Stetson, R. L. pp 240-7 of Radioisotopes for Aerospace. Part I. Dempsey, John C.; Polishuk, Paul (eds.). New York, Plenum Press, 1966.

Isotopic neutron sources are characteristically small, compact, low intensity sources of neutrons. Their development and current availability are reviewed. Prospects for using spontaneously fissioning heavy elements to produce higher intensity sources are considered. (auth)

8545 CORROSION DETECTION WITH A BETA RADIATION PROBE. Badgett, Charles O. (Industrial Nucleonics Corp., Columbus, Ohio). pp 274-96 of Radioisotopes for Aerospace. Part I. Dempsey, John C.; Polishuk, Paul (eds.). New York, Plenum Press, 1966.

The detection of corrosion in its incipient stages is important to preserving structural members of aircraft and other metal equipment. When these surfaces are protected by a protective coating, such as an epoxy resin, it becomes difficult to make this detection of the corrosion without scraping off the protective coating. It is more economical to determine the corrosion areas beneath the protective coating and to remove the coating from only those areas affected. Work is reported which shows the feasibility of accomplishing this feat. (auth)

8546 PROTOTYPE RADIOISOTOPE INSPECTION SYSTEM FOR MEASUREMENT OF PROCESS RESIDUES ON ELECTRONIC CIRCUIT BOARDS. Sturman, I.; Wright, I. J. (TRACERLAB-Richmond, Richmond, Calif.). pp 297-311 of Radioisotopes for Aerospace. Part I. Dempsey, John C.; Polishuk, Paul (eds.). New York, Plenum Press, 1966.

The quantitative measurement of residual solder flux on automatically processed electronic circuit boards is successfully performed by the addition of a radioisotope tracer to the flux. The automatic solder process is briefly described. A large area plastic scintillator beta detector designed and fabricated for this purpose is described, as well as calibration techniques. Health and safety techniques and procedures required because the study was performed in a production area with production personnel are shown to be economically reasonable so that the techniques of radioisotope tracing may be considered as a production control tool. Data show that less than one percent of the flux remained after processing to the applicable specification. (auth)

8547 USE OF A SIMPLIFIED NEUTRON ACTIVATION TECHNIQUE FOR ANALYZING METALLIC WEAR FROM AIRCRAFT HYDRAULIC SYSTEMS. D'Agostino, Michael D.; Kuehne, Frederick J. (Grumman Aircraft Engineering Corp., Bethpage, N. Y.). pp 346-79 of Radioisotopes for Aerospace. Part I. Dempsey, John C.; Polishuk, Paul (eds.). New York, Plenum Press, 1966.

A simplified, inexpensive means of using neutron activation analysis to detect metallic deterioration products filtered out of hydraulic systems was developed. The simplification of established activation analysis techniques was made possible by reducing the analysis of complex gamma ray spectra (resulting from the activation of a mixture of several elements) to a simple procedure, and by the availability of small, inexpensive neutron generators (producing 14.5-MeV neutrons) and multichannel analyzers. The method, developed for routine use by even semi-skilled technicians, involves: activating the total collection of unknown residue with neutrons, measuring the induced gamma ray activity at preselected times, recording the total counts in each of a few selected photopeaks, computing the initial activities of each of the desired radioisotopes, and comparing these initial activities with the corresponding initial activities of simultaneously irradiated standards whose weights are accurately known. An extensive experimental evaluation of the developed simplified activation analysis technique was conducted using a 3-Mv Van de Graaff accelerator and multichannel analyzer equipment to simulate the much simpler and less expensive type of equipment recommended for use in the field. Results of this evaluation indicate that the analysis of metallic wear products filtered out of aircraft hydraulic fluid systems can be accomplished in a routine, inexpensive, and accurate manner, using the simplified technique and a 14 MeV neutron flux of 3×10^8 n/cm^2-sec. (auth)

8548 RADIOISOTOPE AND RADIATION TECHNIQUES FOR TERRESTRIAL AND PLANETARY GAS AND SOLID MEASUREMENTS. Ziegler, Charles A.; Sellers, Bach (Parametrics, Inc., Waltham, Mass.). pp 393-413 of Radioisotopes for Aerospace. Part I. Dempsey, John C.; Polishuk, Paul (eds.). New York, Plenum Press, 1966.

Radiation and radioisotope techniques for measuring the density of gases and compositions of both gases and solids are presented. The apparatus, principles of, and experimental results obtained are described for alpha particle gages, beta attenuation gages, beta scatter gages, x-ray scatter gages, and bremsstrahlung gages used as atmospheric density meters at altitudes from sea level to 600,000 ft. A planetary atmospheric composition measuring system using monochromatic x-ray absorption is detailed. A device for analyzing planetary materials using alpha generated x-ray fluorescence is described. The aerospace applications of these techniques offer advantages over conventional methods due either to small size, weight, and power requirements, or because they are operable under environmental conditions which render conventional methods inapplicable. (L.C.L.)

8549 GAMMA-RAY AND RADAR INTERACTIONS. Kastner, Jacob (Argonne National Lab., Ill.). pp 414-22 of Radioisotopes for Aerospace. Part I. Dempsey, John C.; Polishuk, Paul (eds.). New York, Plenum Press, 1966.

A gamma ray source (a reactor fuel element) was placed in a lead tube ionizing the air above to a height of several hundred feet. The ionized air could be seen by 3 cm radar ¼ mile away. Potential applications are discussed. (auth)

8550 SATELLITE HEATING BY ATOMIC ENERGY. Wyatt, Theodore (to Dept. of Navy). U. S. Patent 3,285,534. Nov. 15, 1966. Filed Aug. 14, 1964.

A temperature stabilized satellite which utilizes waste heat generated by the satellite power supply to maintain constant temperature within the satellite thereby preventing damage to components from thermal stresses and eliminating most thermal insulation is described. The frame of the satellite is metallic. Waste heat from the thermoelectric generator is transferred to the metallic frame by a shim positioned between the generator and the

frame. The shim is of an area and conductivity to permit the flow of the desired amount of heat. (F.S.)

8551 RADIOISOTOPE ATTITUDE CONTROL ENGINE. Friedman, Burnam I.; Martinez, John S.; Jortner, Donald (to TRW Inc.). U. S. Patent 3,280,568. Oct. 25, 1966. Filed Apr. 8, 1963.

A radioisotope attitude control engine is described. The engine provides an efficient and reliable propulsion system with high specific impulse for maintaining attitude stabilization or similar vehicle control for a long-life satellite or space station. It provides a radioisotope heated gas rocket engine for space vehicle maneuvering combining reliability and good performance in providing modest amounts of impulse periodically over long periods of time. It also provides a hot gas intermittent thrustor utilizing a radioisotope heat source. The engine consists of an encapsulated alpha or beta heat source mounted in a heat exchanger, a working fluid storage tank, and one or more nozzles. (F.S.)

8552 NUCLEAR POWERED DRILLING METHOD AND SYSTEM. Muench, Nils L. (to Esso Production Research Co.). U. S. Patent 3,280,923. Oct. 25, 1966. Filed Sept. 21, 1962.

A self-contained down-hole drilling system consisting of apparatus for a new, improved, and economical drilling technique which requires a small operating crew is described. The system consists of a rotary drill bit, an electric motor to drive the bit, a radioisotopic heat source and a thermoelectric cell for generating electric power for operating the motor and other power consuming equipment, means for collecting cuttings from the drilling fluid, a pump for circulating drilling fluid, a pump motor, and a centralizing means for offsetting the torque created by the drill. (F.S.)

8553 IMPROVEMENTS IN OR RELATING TO RADIOACTIVE SOURCES. Faires, Ronald Arthur. (to United Kingdom Atomic Energy Authority). British Patent 1,050,418. Dec. 7, 1966. Filed June 17, 1964.

A soluble low activity radioactive source is described in which ^{22}Na, ^{32}P or ^{131}I is used as the source material. The source is a tablet of a soluble inactive carrier with a soluble compound containing a radioisotope deposited on it. The inactive carrier contains an inactive isotope of the source material chemically combined in the same manner as the radioactive isotope. The activity of the source is less than 1 mCi and not more than 10 μCi. (F.S.)

Materials Testing

Refer also to abstracts 8496, 8543, 8633, 9138, 9142, 9222, and 10208.

8554 (RFP-658) ADVANCES IN METALLOGRAPHY. Technical Papers of the Twentieth Metallographic Conference, Held May 18-20, 1966, Denver, Colorado. Jackson, R. J.; Calabra, A. E. (eds.) (Dow Chemical Co., Golden, Colo. Rocky Flats Div.). Oct. 20, 1966. Contract AT(29-1)-1106. 200p. (CONF-660518-). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

A total of 25 papers were presented at the conference. Separate abstracts were prepared for six papers. Six papers were previously abstracted in NSA as 20:33146, 20:33474, 20:33881, 20:33882, 20:43906, and 20:43941. Papers for which no abstracts were prepared are concerned with contrast microscopy, microstructural discrimination, metallographic polishing tables, metallograph improvements, data handling systems, Ni plating, stainless steel phase identification, Ni coating structure, preparation of samples for microscopy, phase measurements in Pu, and etching Pu. (J.R.D.)

For abstracts of individual papers see: 9144, 9188, 9201, 9202, 9250, 10218, and 10219.

8555 RECENT PROGRESS IN COMPACT FLASH X-RAY SYSTEMS. Dyke, W. P.; Barbour, J. P.; Grundhauser, F. J.; Charbonnier, F. M. (Field Emission Corp., McMinnville, Oreg.). pp 220-39 of Radioisotopes for Aerospace. Part I. Dempsey, John C.; Polishuk, Paul (eds.). New York, Plenum Press, 1966.

A survey of flash x-ray technology was made. The physical characteristics of and the results obtained with flash x-ray systems, radiography, and betagraphy are described and illustrated. The advantages of x-ray systems for communication and ranging are given. The uses of flash x-rays, including radiation effects studies, are presented. The availability of reliable, compact, lightweight flash x-ray systems is discussed. (L.C.L.)

8556 INSPECTION OF JET ENGINES BY RADIOISOTOPE. Walker, H. D. (Eastern Airlines, Inc., Miami, Fla.). pp 312-30 of Radioisotopes for Aerospace. Part I. Dempsey, John C.; Polishuk, Paul (eds.). New York, Plenum Press, 1966.

Radiographic inspection of turbine blade wear and misalignment in jet engines is described. A gamma source was inserted in the hollow center shaft of the assembled jet engine on the aircraft. Lead screened x-ray film was placed 360° around the outside of the outer case of the engine adjacent to the exit guide vanes. Radiographs were obtained which made possible the accurate determination of the amount of wear in the turbine blades and retaining shrouds. The accuracy in wear determination was checked by disassembling the engine. Radiographic inspection of the jet engine on an aircraft can now be accomplished with complete accuracy in 1½ hours lapsed time and 5 man hours as compared with the 5 days lapsed time and 125 man hours previously required. The savings in maintenance of schedule reliability is even more valuable. The use of radiographic inspection for quality control in other engine parts is discussed. Photographs of the complete procedure are shown. (L.C.L.)

8557 NUCLEAR TECHNIQUES FOR NONDESTRUCTIVE TESTING. Berger, Harold (Argonne National Lab., Ill.). pp 331-45 of Radioisotopes for Aerospace. Part I. Dempsey, John C.; Polishuk, Paul (eds.). New York, Plenum Press, 1966.

Radioisotope techniques for radiographic applications are stressed. Gamma and x-radiographic radioactive sources and applications are discussed, the emphasis being on the more unusual sources such as the lower energy gamma emitters, iodine-125 and several rare earth isotopes, and on beta-excited x ray sources employing krypton-85, promethium-147 and strontium-yttrium-90. Neutron radiographic techniques are also discussed concerning their application in the aerospace field. Examples illustrating the usefulness of neutron radiography for imaging such hydrogenous materials as rubber, adhesives, and explosives in steel or other metal assemblies are given. Other potential areas of the application of neutron radiographic methods are indicated and some radioactive neutron source possibilities for radiographic work are discussed. (auth)

8558 AUTORADIOGRAPHY OF PLASTICS COMPOSITE MATERIALS FOR AEROSPACE APPLICATIONS. Choi, Soo San (Philco Scientific Labs., Blue Bell, Pa.); Kinna, Marlin A. pp 380-92 of Radioisotopes for Aerospace. Part I. Dempsey, John C.; Polishuk, Paul (eds.). New York, Plenum Press, 1966.

The use of autoradiography to determine the degree and progress of fatigue in glass-resin composite materials is described. Test specimens were submitted to fatigue tests. The specimens were immersed in a radioactive solution. Excess solution was removed, and further evaporation prevented. The test specimens were coated with a photographic emulsion. The emulsion was processed photographically to obtain autoradiograms which were studied. The radiograms showed the length, diameter, and location of internal fissures and discontinuities in the composite specimens. Tracer analysis offers a reliable technique for the study of internal degradation in fiber reinforced plastic materials. (L.C.L.)

8559 STRENGTH UNDER HIGH TRANSIENT LOADS. Rakhmatulin, Kh. A.; Demyanov, Yu. A. New York, Daniel Davey and Co., Inc., 1966. 348p. $14.00. (IPST-Cat.-2077).

Translated from Prochnost pri Intensivnykh Kratkovremennykh Nagruzkakh by A. Hananel and A. Baruch.

The propagation of waves in nonlinear-elastic and elastic-plastic bars; the theory of transverse impact on flexible deformable joints and beams; propagation of perturbation waves of polar, axial, and spherical symmetry; and propagation of disturbances in elastic and plastic media possessing viscous properties and displaying the phenomena of creep and relaxation are discussed. (R.C.K.)

Protective Structures

8560 (URS-658-3) COMBINED EFFECTS OF NUCLEAR WEAPONS ON NFSS TYPE STRUCTURES. Final Report. Wiehle, Carl K.; Durbin, William L. (URS Corp., Burlingame, Calif.). Sept. 1966. Contract OCD-PS-64-201. 103p.

The primary objective of this program was to examine and evaluate the protection afforded by the types of structures found in the National Fallout Shelter Survey (NFSS) against the combined effects of nuclear weapons. Since a major criterion for the designation of the NFSS structures was the radiation protection factor (PF) of the structure, the approach adopted in this investigation was to examine the sensitivity of the PF for idealized building situations to alteration by air blast and fire damage. To accomplish this, interim techniques were developed for estimation of the air blast loading and damage to selected types of structures. These techniques were developed by utilizing available experimental data together with engineering judgment to modify current generalized blast loading schemes. The procedure adopted to predict damage was to determine the blast loading on each building component and then to compare this loading with the failure loading for the component. By utilizing fire prediction information, a method was developed for deter-

mining the fire damage within the building. To predict damage to the various building elements by this procedure, the duration of the peak fire was calculated and then compared with the rated resistance of the components. (auth)

8561 SLOT DOZER TRENCH AS A FALLOUT SHELTER FOR FIELD MEDICAL UNITS. Roudebush, Daniel L. (Armed Forces Radiobiology Research Inst., Bethesda, Md.). Military Med., 131: 1408-12(Nov. 1966).

Field hospitals must provide, in advance of any fallout event, adequate fallout shelter for the protection of both personnel and patients. In terms of least man-equipment-hours required, the slot dozer trench offers a unique means of providing rapid fallout protection. For example, ~1200 ft of trench, 9 ft wide and 3 ft deep, can be dug by one standard Army D-8 dozer in one 10-hr man day. Such a large potential fallout shelter (up to 600-man capacity) would provide residual radiation protection when covered. Calculations were made to predict protection factors for large dozer trenches capable of housing an Army field hospital. These calculations showed that the slot dozer trench can provide a protection factor of at least 10. It was shown that for a given depth, the narrower the trench, the better the protection factor. As a rule of thumb, if a large ditch is desired, the depth should be increased 2-fold for every 2-fold increase in width in order to maintain the same protection factor. Such a trench offers the possibility of a fallout shelter capable of assuring survival of staff and patients of military field hospitals in all but an extremely limited close-in position of the fallout pattern, and minimizes demands for engineering assistance. Personnel are thus assisted in maintaining a Full Remaining Radiation Service status. (BBB)

8562 NUCLEAR BLAST DETECTOR. Cotterman, Robert William; Wright, Warren H. (to International Telephone and Telegraph Corp.). U. S. Patent 3,281,811. Oct. 25, 1966. Filed Jan. 2, 1963.

A nuclear blast detector is described which could be used to close the door of a fallout shelter, set off a civil defense alert, or start the motor of a launch vehicle. The detector responds to the first fast rising thermal pulse and the second slow rising thermal pulse. The pulses are detected by infrared spectrum detectors. The detector consists of a hardened antenna, electronic logic circuitry connected to the antenna, and an alarm. (F.S.)

8563 CLOSURE DEVICE FOR SHAFTS, MORE PARTICULARLY IN AIR RAID SHELTERS. (to Luwa AG). British Patent 1,050,685. Dec. 7, 1966. Priority date Sept. 11, 1962 and Oct. 5, 1962, Switzerland.

A closure device is described which may be used for shafts, particularly emergency exits, and escape passages of air raid shelters. The shaft must have an outer frame, an intermediate frame pivotally mounted in the outer frame, and a pivotally mounted cover, mounted in the intermediate frame. The cover opens in an outward direction only. An actuator is attached on the inside and the exterior of the shaft. The closure is water and gas tight. (F.S.)

Radioactive Material Handling

Refer also to abstracts 8500, 8509, 8511, 9201, and 9202.

8564 (DP-1081) AUTOMATIC SYSTEM FOR THE PREPARATION OF CULTURE MEDIA. Harvey, Raymond S. (Du Pont de Nemours (E. I.) and Co., Aiken, S. C. Savannah River Lab.). Nov. 1966. Contract AT(07-2)-1. 8p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

An automatic system was developed to reduce the manpower and laboratory space required for the preparation and storage of synthetic media for long-term continuous flow studies with mass cultures of algae. This equipment was designed to supply culture media containing radionuclides for tracer studies with algae; however, it can be easily modified to continuously supply a variety of solutions for laboratory investigations. This system is compact, accurate, and requires little maintenance. (auth)

8565 (ORNL-4007, pp 1-41) RADIOACTIVE WASTE DISPOSAL. Parker, F. L. (Oak Ridge National Lab., Tenn.).

Continuing studies of the field plots show a reduced rate of loss of ^{137}Cs in the fall and winter months of the second year. There is a logarithmic relationship between ^{137}Cs loss and the soil loss. Mass balance analyses do not provide a satisfactory accounting of the total ^{137}Cs applied to the clipped meadow plot. Studies of the selective adsorption of cobalt by layer lattice silicates show that adsorption is influenced by the method of sample preparation. With identical sample preparation techniques, trioctahedral lattices sorb more cobalt than comparable minerals with dioctahedral lattices. The most probable failure mechanisms limiting the ultimate capacity of the shale formation in the hydraulic-fracturing waste-disposal method appear to be related to the stresses induced in the rocks surrounding the injection by the injection itself. The problem of defining the number and size of injections required to produce a failure condition is under investigation using electric analysis. Examination of the nuclide retention properties of the set grouts, especially those containing low-cost fly ash, continued. Final preparations for Project Salt Vault were completed. In addition to experimental equipment, a hoist and ventilation fan were installed at the waste shaft. Prior to startup of the experiment, a number of preoperational tests were conducted using both empty fuel assembly canisters and canisters loaded with 500 curies of ^{60}Co. A number of minor modifications to both the equipment and the handling procedures were made as a result of these tests. In the event of a nuclear incident involving fuel element meltdown, ^{131}I appears to present the most serious short-term hazard. If the radioactive gases could be pumped underground, the delay time afforded by adsorption and by physical movement through the porous medium and dilution would cause a reduction in the relative hazard by a few orders of magnitude. Strontium-90 would present the most serious potential for contaminating groundwater near the site of discharge. Laboratory studies conducted on the sorption of iodine by clays suggest that the iodine consists of condensed I_2 and chemisorbed I_2. Samples leached with water retain a finite quantity of I_2, also suggesting a fixed capacity for the chemisorption of iodine. A computer program has been written to describe the transient behavior of radionuclides in the ground when the transporting solution is of a different concentration than the original groundwater. Experimental data, obtained on a Berea sandstone for different sets of conditions, confirm the suitability of Glueckauf's model for the passage of a wide band of solute through a chromatographic column, modified for changes in the adsorptive capacity due to changes in the total electrolyte concentration and for nonequilibrium sorption conditions. Preliminary data on curium behavior suggest that mechanisms other than ion exchange may play dominant roles in its behavior in the ground. An age-dependent metabolic model was used to estimate dose equivalents received by the skeleton from ingestion of Clinch River water. For the age groups considered, this model gave an average dose 15% larger than the adjusted ICRP model. The dose rate associated with buildup of ^{85}Kr in the atmosphere and ^{3}H in the atmosphere and circulating water was estimated for an expanding free-world nuclear power economy. For complete releases to year 2000, the estimated whole-body dose rate from ^{85}Kr was 1.8 millirems/year in the first ¼ mile of the atmosphere and the body tissue dose rate from ^{3}H was 7.2×10^{-4} millirem/year by inhalation and 1.4×10^{-3} millirem/year by ingestion of water. (R.C.K.)

8566 (ORNL-4017) LABORATORY DEVELOPMENT OF PROCESSES FOR FIXATION OF HIGH-LEVEL RADIOACTIVE WASTES IN GLASSY SOLIDS. 5. CONTINUOUS FIXATION OF AQUEOUS WASTE: THE CON-POTGLASS PROCESS. Clark, W. E.; Fitzgerald, C. L. (Oak Ridge National Lab., Tenn.). Jan. 1967. Contract W-7405-eng-26. 19p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Simulated Purex wastes were solidified in semi-engineering-scale equipment by using a continuous melting process. Operation was simpler than that of either the pot calcination (Potcal) or the rising-level glass (RL-Potglass) process previously developed at ORNL. Volatilities of simulated fission products were about the same as that in the other two processes. Melts with viscosities ≦ 20 poises were preferred for the most satisfactory operation. Excessive corrosion of the melter vessel is the principal disadvantage of the process. Rates of attack on potentially useful high-nickel alloys in phosphate melts at 900°C varied between 120 and 626 mils/month. Lead silicate melts had the lowest corrosion rates of the melts tested, with maximum penetration of about 20 mils/month. (auth)

8567 (TID-3311(Suppl.2)) RADIOACTIVE WASTE PROCESSING AND DISPOSAL. An Annotated Bibliography of Selected Literature. Davis, Theodore F. (comp.) (Division of Technical Information Extension (AEC), Oak Ridge, Tenn.). July 15, 1966. 182p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

1,012 references on waste processing and disposal from the unclassified report and journal literature from February 1965 through July 15, 1966, are given. References are subject-arranged and numerous cross references are provided. Author, corporate author, and report number availability indexes are included. (F.S.)

8568 (UJV-1609) FIXACE RADIOAKTIVNICH ZBYTKU CEMENTEM. (Fixation of Radioactive Cement Sludges). Schejbalova, L.; Novotny, J. (Ceskoslovenska Akademie Ved, Rez. Ustav Jaderneho Vyzkumu). 1966. 45p. (In Czech). DTIE.

Several brands of cement were tested for the fixation of radioactive concentrates. The effect of the mechanical composition of sludges and concentrates on the mechanical properties of the hardened cement paste and on the extractability of incorporated

radioactive species was examined. While Portland Cement 350 proved to have been most suitable for the fixation, the aging processes in the hardened cement paste were found to suppress the extractability of radioactive species. (auth)

8569 FUNDAMENTAL STUDIES ON BEHAVIOR OF CESIUM IN FIXATION OF RADIOACTIVITY IN CERAMIC SPONGES. Tagai, Hideo; Lim, Eung Keuk (Tokyo Inst. of Tech.). Bull. Tokyo Inst. Technol., No. 71, 1-86(Mar. 1966).

One method for the disposal of fission-product wastes from the reprocessing of the spent uranium fuels is the fixation of the fission products on ceramic sponges, which are then stored underground. This method of fixation of high-level radioactivity is described. Studies were made on the leachability for long-period underground storages, mechanisms of the fixation and adsorbability of the radionuclide ^{137}Cs. The conclusions on the behavior of ^{137}Cs in the fixation of radioactive wastes in ceramic sponges are as follows: ceramic sponges having 56 to 65% porosity were prepared from materials including diatomite, bentonite or clay, and feldspar. The compositions found to be promising by the determination of the physical properties are 60 to 70% diatomite, 20 to 30% bentonite and 10% feldspar; the adsorption test was carried out with ^{137}Cs as $CsNO_3$ for 17 kinds of vitrified material. It was found that the adsorbability depended on the ion exchange capacity; a test was done on the fixation of ^{137}Cs on a vitrified mullite tube by firing at 1250°C for one hour. The results showed that no volatilization occurred by this firing; and the leaching test showed that nearly all of the leachable radionuclides appeared during the first 24 hours. (NSA of Japan)

8570 EFFECT OF β-ACTIVE RADIONUCLIDE ADSORPTION AT WALLS OF MEASURING FLASKS ON THE DETERMINATION OF ACTIVITY. Svoboda, K. (Inst. of Nuclear Research, Czechoslovak Academy of Sciences, Rez). Isotopenpraxis, 2: 413-17 (Nov. 1966). (In German).

The effect of the adsorption of β-active radionuclides from liquid samples at walls of measuring flasks on the results of activity measurements has been determined theoretically. Moreover, the role of carriers is discussed. The possibilities of evaluating the results of studies of adsorption and desorption are described. The theoretical conclusions are demonstrated by the example of elementary ^{128}I present in ethyl iodide in microconcentration. (auth)

8571 THE IMPACT OF THE IAEA REGULATIONS ON THE TRANSPORT OF IRRADIATED FUEL. Fairbairn, A.; Gibson, R. (United Kingdom Atomic Energy Authority). J. Brit. Nucl. Energy Soc., 5: 558-63(Oct. 1966).

Regulations recently developed by the International Atomic Energy Agency for the carriage of large radioactive sources, particularly irradiated nuclear fuel, are described. Emphasis is laid on the need for these international transport requirements to be taken into account at an early stage in reactor projects. The implications of the regulations for designers of irradiated fuel packaging are examined, and attention is drawn to some specific problems. (auth)

8572 METHOD FOR THE DISPOSAL OF WASTE SOLUTIONS USING RIGID GELS. Pitzer, Edgar C. (to U. S. Atomic Energy Commission). U. S. Patent 3,298,960. Jan. 17, 1967.

A method was developed for the disposal of radioactive waste solution by adding a gelling agent to a solution of hydrazine and ethylenediaminetetraacetic acid containing dissolved radioactive wastes in an amount sufficient to produce a solid vibrant gel. (AEC)

INSTRUMENTATION

Radiation Detection Instruments

Refer also to abstracts 8451, 8501, 8655, 9189, and 9877.

8573 (AD–634040) DEVELOPMENT OF AN AUTOMATIC REMOTE RADIATION MONITORING (ARRM) SYSTEM. Final Engineering Report. Fox, Stewart A. (Nuclear-Chicago Corp., Des Plaines, Ill.). Dec. 31, 1965. Contract OCD-OS-63-183. 93p. CFSTI $3.00 cy, $0.65 mn.

Engineering and performance data on a prototype remote automatic monitoring system designed for use in local emergency operating centers are reported. The development effort included, but was not limited to, design and construction of a detection system which transmits digital radiation data on command from a remote monitor location; incorporation of sensor station identification for serial line systems; production of one complete ten sensor station system for field evaluation. The system described will transmit data over commercial telephone lines and provide control for operation of radio frequency communication equipment. An investigation of data storage and retransmission systems was performed. (TAB)

8574 (AD–643540) STANDARDIZED METHOD FOR MAKING NEUTRON FLUENCE MEASUREMENTS BY FISSION FRAGMENT TRACKS IN PLASTICS. Pretre, S.; Tochilin, E.; Goldstein, N. (Naval Radiological Defense Lab., San Francisco, Calif.). Oct. 19, 1966. 32p. (USNRDL-TR–1089). CFSTI $3.00 cy, $0.65 mn.

A neutron detector is described which consists of a fission foil (^{232}Th, ^{235}U, ^{238}U, ^{237}Np or ^{239}Pu) in contact with a plastic track detector. These detectors were exposed to reactor neutrons and to monoenergetic neutrons with energies between 1.0–18 MeV. Fission fragment tracks registered in the plastic were selectively etched by an hydroxide and counted in an optical microscope. For thick foils of fissionable metals the sensitivity of the system was found to be $(1.16 \pm 3\%) \cdot 10^{-5}$ (fission fragment tracks/neutron–barn) which is in good agreement with theoretical calculations. This sensitivity is independent of the fissionable element used, independent of the neutron energy, fairly independent of the material chosen for track registration (plastics, glass, mica) and of etching conditions. Since the (n,f) cross sections are accurately known for most neutron energies, the above constant can also be used for standardized measurements of neutron fluences. (auth)

8575 (CEA-R–3046) APPAREIL DE MESURE DE CLICHES DE CHAMBRE A BULLES. (Apparatus for Measuring Bubble Chamber Pictures). Miet, Roger; Calmels, Christian (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Oct. 1966. 13p. (In French). Dep. mn.

A description is given of a new type of measuring projector for bubble chamber pictures named BICHE, especially adapted to chambers with 4 cameras and 50 mm film (50 × 150 mm pictures). This apparatus is of a conventional type, with fixed film and movable optics (objectives, arrow and illumination). It has the following advantages: The projection of each picture occurs simultaneously on two screens with two different magnifications, 6 and 25. The measurement is made on magnification 25, allowing high precision. On the magnification 6 screen, the whole picture is seen for control. The loading and unloading of the spools is very simple; it is made outside the apparatus. The total bulk of the projector is rather small. (auth)

8576 (DESY–66/29) NEW PLOTTING CONCEPT FOR DATA FROM BUBBLE CHAMBER EXPERIMENTS. Butenschoen, H. (Deutsches Elektronen-Synchrotron, Hamburg (West Germany)). Oct. 1966. 4p. Dep. mn.

A new concept was developed for plotting one- and two-dimensional distributions of kinematic quantities in bubble chamber experiments in connection with plotting programs such as ULTRAN or SUMX with a great saving of time. Applied to an experiment with large statistics, the new program (HYBRID-ULTRAN) has yielded a saving of time of more than 90% as compared to conventional methods. (auth)

8577 (JINR–P10-3021) METODY UCHETA KULONOVSKOGO RASSEYANIYA I TORMOZNOGO IZLUCHENIYAPRI OBRABOTKE KAMERNYKH TREKOV. (Methods Taking Account of Coulomb Scattering and Bremsstrahlung for Bubble Chamber Tracks Treatment). Budagov, Yu. A.; Vinogradov, V. B.; Volod'ko, A. G.; Gerdyukov, L. N.; Zhelepov, V. P.; Klimenko, S. V.; Norikov, V. G.; Patochka, I.; Flyagin, V. B.; Shlyapnikov, P. V. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). 1966. 37p. (In Russian). Dep. mn.

Methods for determining the kinematic parameters for bubble chamber tracks are considered taking into account fluctuations due to Coulomb scattering and bremsstrahlung. A related computer-program is analyzed in which, by a least squares method using both measurement and scattering matrices, curve with varying curvature is fitted. From this bremsstrahlung is deduced. The validity of the methods suggested is checked with pictures from the JINR 1m propane bubble chamber in a beam of 5 GeV/c negative pions of the JINR synchrophasotron. (auth)

8578 (JINR–P10-3023) K VOPROSU O VYBROSE PLOKHO IZMERENNYKH TOCHEK NA TREKAKH POLUCHAEMYKH V PUZYR'KOVOI PROPANOVOI KAMERE. (On a Rejection of Poorly Measured Track Points). Benshova, Ya.; Vrana, I.; Marek, I. (Joint Inst. for Nuclear Research, Dubna (USSR)). 1966. 7p. (In Russian). Dep. mn.

A new method to reject poorly measured track points is suggested for a geometric track reconstruction in bubble chambers. The circle arc is laid through the measured points by the least squares method. (auth)

8579 (JINR–P13-2965) APPARATURA DLYA IZMERENII UGLOVYKH RASPREDELENII YADER ^{17}N, VOZNIKAYUSHCHIKH V REAKTSIYAKH PEREDACHI S TYAZHELYMI IONAMI. (The Equipment for the Measurement of the Angular Distribution of ^{17}N Produced in the Heavy Ion Transfer Reactions). Volkov, V. V.; Pomorski, L.; Tys, Ya. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Reactions). 1966. 17p. (In Russian). Dep. mn.

Equipment which is used in the investigation of the heavy ion transfer reaction by detection of delayed neutron activity of ^{17}N is described. The equipment consists of a reaction chamber, a neutron detector, and electronic and electromechanical parts. The equipment permits measurement of the differential cross sections of the reactions and the energetic distributions of the reaction products. (auth)

8580 (JINR–P13-2998) STRIMERNAYA KAMERA, UPRAVLYAEMAYA PROPORTSIONAL'NYMI SCHETCHIKAMI, DLYA REGISTRATSII OSTANOVOK MEDLENNYKH MEZONOV. (A Streamer Chamber Triggered by Proportional Counters Designed to Register Stopping Mesons). Kulyukin, M. M.; Pontekorvo, D. B.; Falomkin, I. V.; Khazins, D. M.; Shcherbakov, Yu. A. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). 1966. 12p. (In Russian). Dep. mn.

A streamer chamber 140 mm high and 400 mm in diameter filled with helium with a 1% admixture of methane was made in order to register slow mesons stopping in the gas volume of the chamber. A multiwire proportional counter was constructed for selecting stopping slow mesons. It is shown that it is possible to operate both the counter and the chamber together in intensive meson beams. The chamber is triggered by two such multiwire proportional counters. The counters and the chamber have a common gas volume. A scintillation counter with a thin scintillator (1 mm) is used for preliminary selection of slow mesons. The properties of the chamber when it is operated in a charged particle beam with a repetition rate of 1 sec^{-1} and a time delay of some microseconds are discussed. Photographs of μ_e-decays are presented. The structure of tracks and its dependence upon the specific ionization of the registered particles is discussed. (auth)

8581 (KFK-426) ELEKTRONISCHE SICHERUNG MIT μA-ANZEIGE FUER HALBLEITERDETEKTOREN. (Electronic Safety Devices with μA Readings for Semiconductor Detectors). Kind, Joachim (Kernforschungszentrom, Karlsruhe (West Germany). Institut fuer Experimentelle Kernphysik). Mar. 1966. 15p. (In German). Dep. mn.

The operation of semiconductor detectors requires a slow and steady rise of the current up to the final value as well as continuous control of the set current in the operating range, since exceeding the permissible current, which in many cases is only a few microamperes, may destroy the expensive semiconductor detectors. An electronic protective device is described. This equipment allows the separate simultaneous connection up to four semiconductor detectors. A time constant takes care of a slow and steady rise of the set currents to the ultimate value. Four separately adjustable electronic fuses protect the semiconductor detectors. The supply currents can be read from installed instruments. (auth)

8582 (NP–16424) THE CONSTRUCTION, CALIBRATION, AND OPERATION OF THE UNIVERSITY OF MINNESOTA EXPERIMENTS FOR OGO-I AND OGO-III. Technical Report No. CR–87. Kane, S. R.; Pfitzer, K. A.; Winckler, J. R. (Minnesota Univ., Minneapolis. Cosmic Ray Group). Sept. 1966. 48p.

Estimates of the response characteristics of the ionization chamber and electron spectrometer experiments flown on the OGO-I and OGO-III satellites are reported. A cross-calibration between the ion chamber and spectrometer is described. (J.H.M.)

8583 (AEC-tr-6641, pp 185-91) PROPORTIONAL 4π-COUNTER FOR MEASUREMENTS OF LOW BETA-ACTIVITIES UNDER MARINE CONDITIONS. Kotlyarov, K. A.; Khitrov, L. M. Translated from Radioaktivnaya Zagryaznennost' Morei i Okeanov, Izdatel'stvo Nauka, Moscow, 1964.

A 4π proportional detector used on research vessels to measure low β activities under marine conditions is described. It has high efficiency with the lowest possible background and is used in measuring β activities of ^{90}Sr, ^{144}Cs, ^{7}Be, and ^{14}C. The counter is easily assembled, incorporates a power supply to exclude interference, and has an electronic circuit designed for simplicity and economy. (F.S.)

8584 RESOLVING TIME DETERMINATION OF GEIGER-MUELLER COUNTERS WITH ^{137m}Ba. Marais, P. G.; Karsten, J. H. M.; van der S. Lotz, E.; van R. Smit, J. (Fruit and Food Tech. Research Inst., Stellenbosch, S. Afr.). S. Afr. J. Agr. Sci., 9: 253-8(1966).

Barium-137m, the half-life of which is now accurately known as 153.08 ± 0.04 sec, was used to determine the resolving times (τ) of G-M counters, but a different procedure was adopted from that used previously. Earlier authors followed the decay of ^{137m}Ba until the counting rate was sufficiently low for the decay curve to be linear, and calculated τ from an extrapolation of this linear portion of the curve. However, limitations of this procedure were caused by the inaccurate tail of the decay curve. A shorter and more accurate procedure was used here. Barium-137m was eluted from a small column of the cation-exchanger ammonium 12-molybdophosphate onto which ^{137}Cs had been adsorbed. Most of the equilibrium barium activity was found in the first drop, and each sample consisted of one or two drops collected in a barium carrier solution, which was then placed adjacent to the G-M counter. Counting rates were thus determined at intervals during the decay of ^{137m}Ba and τ was calculated with the relative activity method. Similar results were obtained whether a stopwatch or electronic switch was used for counting rate determinations, and it was found that τ remained constant up to a counting rate of 80,000 cpm where resolving time losses were as high as 50%. The standard errors of single τ determinations could be reduced to less than 1% by increasing the counting rate to 80,000 cpm. (BBB)

8585 MICROAUTORADIOGRAPHIC METHOD OF DETERMINING RADIOACTIVE ELEMENTS. Zaborenko, K. B.; Korobkov, V. I. (Moscow State Univ.). Agrokhimiya, No. 9, 153-8 (Sept. 1966). (In Russian).

Autoradiographic methods for the identification of α-emitting isotopes were studied. Results of measurements of α-emission from ^{230}Th, ^{147}Sm, ^{218}Po, ^{214}Po, ^{235}U, ^{238}U, and ^{234}U are tabulated and compared with measurements of α-emission from ^{229}Th. The efficiency of the method is discussed. (R.V.J.)

8586 ARRANGEMENT AND CALIBRATION OF A Ge:Li GAMMA DETECTOR. Prieels, R.; Vlieghe, P. (Univ., Louvain, Heverle, Belg.). Ann. Soc. Sci. Brux. Ser. I, 80: 277-88 (Dec. 28, 1966). (In French).

The installation and standardization of a gamma detection system with high energy resolution is described. The detector was a Ge : Li crystal with a nominal thickness of 2 mm in the adjusted zone. A typical width at half maximum of 4.5 to 122, 6.7 to 1333, and 9.5 to 2614 keV was obtained. In the detection of pair production events the width at half maximum obtained was 8 keV for a gamma ray of 2614 keV. The factors affecting the resolution and the pulse height are discussed in detail. Experimental values for the efficiency for photoelectric and Compton effects and pair production are compared with theoretical values calculated for a 2-mm detector. (tr-auth)

8587 SEMICONDUCTOR RADIATION DETECTORS FOR AEROSPACE APPLICATION. Trice, James B. (General Electric Co., Philadelphia). pp 88-101 of Radioisotopes for Aerospace. Part I. Dempsey, John C.; Polishuk, Paul (eds.). New York, Plenum Press, 1966.

The physical and functional characteristics of contoured amplifying detectors developed over the past four years are described. Applications of these detectors to several aerospace requirements of an engineering and scientific nature are presented in terms of those specific contributions that can be made to missile and satellite instrumentation. The achievements made possible through these sensors are: high speed and time resolution that approaches a nanosecond; the ability to measure x-ray energies as low as one kilovolt or less; and the major reduction in size or elimination of preamps and amplifiers. (auth)

8588 STOCHASTIC POPULATION PROCESS AND ITS APPLICATION TO BUBBLE CHAMBER MEASUREMENTS. Brockwell, P. J.; Moyal, J. E. (Argonne National Lab., Ill.). J. Appl. Probab., 3: 280-4(June 1966).

A particle travels along the half-line $[O,\infty]$ in such a way that it has probability $\lambda\delta U + O(\delta U)$ of generating an event in any small element $(\mu,\mu + \delta U)$ of its track. The particle is observed only in the line segment $O \le u \le x$ and successive events occur at $X_1, X_2, \ldots, X_n$ $(O \le X_1 \le X_2 \le \ldots \le X_n \le x)$ where $X_1, \ldots, X_n$ are random variables and the number n of events $[O,x]$ is also random. The distances $Y_1 = X_1$ and $Y_i = X_i - X_{i-1}$, $2 \le i \le n$, constitute a finite univariate population process as defined by Moyal (Acta. Math. 108: 1-31(1962)). A complete description of the population process generated by the Y_i is presented. The probability generating function for the process is determined and used to find explicit expressions for the kth order factorial moment densities and the distribution of the number of distances Y_i such that $Y_i \ge d$. It is assumed throughout that the mean free path λ^{-1} for bubble formation is unity. This implies no loss of generality, being equivalent to measuring all distances in units of λ^{-1}. (B.G.D.)

8589 METHODICAL REMARKS ON THE DETERMINATION OF THE DISTRIBUTION OF TRANSVERSE MOMENTUM OF SECONDARIES PRODUCED IN ULTRA-HIGH-ENERGY INTERACTIONS BY MEANS OF THE MULTIPLE-SCATTERING METHOD. Tomaszewski, A. (Inst. of Nuclear Research, Lodz, Poland); Michalak, W.; Sroka, J. Nuovo Cimento (10), 46A: 760-5 (Dec. 21, 1966).

Various sources of errors in the determination of the transverse-momentum distribution of secondary particles in multiple-scattering measurements are pointed out; the main difficulty being connected with the determination of noise for the particular tracks. It is pointed out that the noise level depends on the dip angle in emulsion and thus the upper limit of momentum which can still be determined varies for the particular tracks. A quantitative criterion is given based on the determination of the maximum detectable transverse momentum for each track. Experimental relations are obtained for the dependence of spurious scattering on dip angle and cell length, and are used in calculations on tracks from 30 jets from the ICEF stack. (L.B.S.)

8590 TRANSFER FUNCTION MEASUREMENT OF IONIZATION CHAMBERS WITH THE USE OF UNCORRELATED REACTOR NOISE. Gotoh, Seiichiro. J. Nucl. Sci. Technol. (Tokyo), 3: 359-62(Sept. 1966).

The frequency response of an ionization chamber was measured by utilizing the uncorrelated reactor noise, varying the voltages as parameters. The results obtained made it clear that the break frequency of the ionization chamber is determined by the transit time of positive ions and the applied voltage, and can further be represented by a simple first order time lag. (auth)

8591 FOUNDATIONS OF CALCULATIONS FOR ERROR STATISTICS IN NUCLEAR RADIATION MEASUREMENT TECHNIQUES. PART IV. Weise, Lothar (Zentralinstitut fuer Reaktorexperimente, Juelich, Ger.). Arch. Tech. Messen, No. 366, 155-60(1966). (In German).

Statistically determinate errors in registration of impulse spectrograms include influence of the rate meter time constant in single channel spectrometry and the influence of the finite channel width of a spectrometer. Choice of rate meter time constants with a constant background and a criterion for distinguishing a true line and statistical fluctuations of the background are discussed. The development of a pulse height spectrum into an energy spectrum of nuclear radiation is discussed. Comments on the form of a scintillation spectrum originating from a monoenergetic source of γ radiation are made. Solutions to the problem of conversion to an energy spectrum are outlined: the matrix method and an iterative method for the solution of the pertinent equations are outlined, and a few other methods are briefly mentioned. (BBB)

8592 PREPARATION AND EXAMINATION OF A SIGNAL-SHAPE DISCRIMINATING PLASTIC. Binder, Gyula; Kiss, Gabor (Central Inst. of Physical Research, Budapest). Magyar Fiz. Foly., 14: 457-61(1966). (In Hungarian).

A signal-shape discriminating plastic scintillator may be used for the separation and simultaneous determination of scintillation signals due to fast neutrons and γ radiation. At present, the only commercially available material for this purpose is the product NE-150; however, its low softening point near 40°C renders it unsuitable for general use. A series of polyvinyl toluene-base mixtures containing varying amounts of p-terphenyl and POPOP were prepared under exclusion of oxygen and examined as to their suitability for this purpose. The results indicated that the discriminating ability increases with the increasing terphenyl content; it is only slightly affected by the concentration of the other two components in the mixture. The mixture containing 4 wt. % p-terphenyl

and 0.06% POPOP was found to be equivalent to the commercial product, even though its softening point was around 75°C. (TTT)

8593 SOME REMARKS ON THE DIMENSIONING OF THE COLLECTION TIME CONSTANT OF SCINTILLATION HEADS. Brunner, G. (Institut fuer Angewandte Radioaktivitaet, Leipzig). Isotopenpraxis, 2: 418-19(Nov. 1966). (In German).

The effect of the scintillation head collection time constant on the temperature response of the output pulse height is discussed. The conditions of fully suppressing or, at least, essentially reducing the temperature effect in using NaI(Tl) scintillators were determined. (auth)

8594 PRACTICAL METHOD FOR EVALUATING THE NEUTRON DOSE EQUIVALENT RATE. Yoshida, Yoshikazu; Tatsuta, Hatsumi; Ryufuku, Hiroshi; Kitano, Kyoshiro; Fukuda, Seiji (Japan Atomic Energy Research Inst., Tokyo). J. Nucl. Sci. Technol. (Tokyo), 3: 473-8(Nov. 1966).

A practical method applicable to field monitoring with survey instruments is presented, which permits evaluation of the dose equivalent rate for neutrons, the spectrum of which is unknown but with energy ranging from epithermal to fast. The detectors employed consisted of a BF_3 proportional counter with paraffin moderators 6.5 cm and 1.0 cm thick, sheathed in 0.5 mm thick Cd, and a scintillation (ZnS and plastic) counter. The dose equivalent rate D(mrem/hr) of neutrons with a broad spectrum was determined from the equation $D = D_B + D_S$, where D_B is the dose equivalent rate determined from the effective neutron flux and the effective neutron energy through the counting rates obtained with the BF_3 proportional counter with paraffin moderators, and D_S the dose measured with the scintillation counter, the sensitivity of which is nearly proportional to the dose equivalent rate for neutrons above 2 MeV. The error in evaluating the dose equivalent rate by the present method was calculated to be at most 60% for typical neutron spectra, in the energy range from epithermal to 10 MeV. (auth)

8595 ACCELERATION CONTROLLED DRIVE WITH CONSTANT ACCELERATION FOR MOESSBAUER EXPERIMENTS. Pahor, J.; Kelsin, D.; Kodre, A.; Hanzel, D.; Moljk, A. (Stefan Nuclear Inst., Ljubljana, Yugoslavia). Nucl. Instrum. Methods, 46: 289-92(1967).

Operation of an electromechanical driving system above the resonant frequency of the transducer by use of a rectangular driving signal and an acceleration controlled feedback is described. The modification of the rectangular input signal by the addition of signals of parabolic and triangular form and appropriate size is introduced in order to control the motion in the forward path and to keep the feedback low. (auth)

8596 HIGH-RESOLUTION HIGH-LUMINOSITY BETA-RAY SPECTROMETER DESIGN EMPLOYING AZIMUTHALLY VARYING MAGNETIC FIELD. Bergkvist, K.-E.; Sessler, A. M. (Univ. of California, Berkeley). Nucl. Instrum. Methods, 46: 317-24(1967). (UCRL-16802).

A double-focusing magnetic field for a spectrometer of the flat type which gives radial focusing to roughly the sixth order, and which utilizes azimuthal variation of the field coefficients, was devised. In the type of magnetic field assumed, the nonvanishing component B_z in the symmetry plane z = 0 may be written. A computer and some basic analytic properties of the aberration coefficients were employed to arrive at appropriate values of the field constants D_{mn}. The focusing angle is 6 rad, within which there is one intermediate axial focus. The magnitude of the ratio of the momentum dispersion to the radial magnification is approximately 12; this means that the spectrometer, for a given resolution, will accommodate a source that is three times as broad as the source of the well-known $\pi\sqrt{2}$ type. For a point source and a solid angle of 0.9% of 4π, the momentum resolution is 0.01%. In the present field the total source height is limited to about three times the source width due to the presence of a fairly large second-order cross term between the source height parameter and the axial aperture parameter. It is found, however, that by a slightly different choice of $a_2(\theta)$ such a cross term can be eliminated. The general possibility of control of cross terms, as indicated by this result, could be of considerable value if a system of very high luminosity should be attempted, for instance by using an azimuthally varying magnetic field in conjunction with a recently developed electrostatic method for reducing the influence of source width resolution. Some comments are made on the problem of realizing an azimuthally varying field of the present type. (auth)

8597 PHOTOPEAK AND DOUBLE-ESCAPE PEAK EFFICIENCIES OF GERMANIUM LITHIUM DRIFT DETECTORS. De Castro Faria, N. V.; Levesque, R. J. A. (Univ., Montreal). Nucl. Instrum. Methods, 46: 325-32(1967).

Theoretical calculations by the Monte Carlo method of the intrinsic efficiencies, photo and double-escape fractions of Ge(Li) drift detectors for parallel beams of gamma rays in the range of energy from 100 keV to 10 MeV. For the photopeak efficiencies the calculations were made from 100 keV to 1.5 MeV and for the double-escape peak efficiencies, they were carried for energies greater than 1.5 MeV. The detectors considered were cylinders having 18 mm dia. and depletion depths of 2, 3.5, 4, 5, 6, 7, 8, 9, and 10 mm. The results are compared with the experimental values obtained by Ewan et al. with an 18 × 3.5 mm detector, for both the photopeak and the double-escape peak efficiencies and with a 5 cm^2 × 8 mm for the full energy peak efficiency. (auth)

8598 FINITE SOLID ANGLE CORRECTIONS TO ANGULAR CORRELATIONS FOR SQUARE Ge(Li) GAMMA DETECTORS. Avida, R.; Atzmony, U.; Unna, I. (Hebrew Univ., Jerusalem). Nucl. Instrum. Methods, 46: 350-4(1967).

Geometrical corrections for angular correlation measurements with square Ge(Li) detectors and extended linear sources are calculated. (auth)

8599 PARTICLE IDENTIFICATION BY PULSE-HEIGHT CORRELATION IN A RANGE TELESCOPE. Groom, D. E.; Marshall, J. H. (California Inst. of Tech., Pasadena). Contract AT (11-1)-68. Nucl. Instrum. Methods, 46: 293-300(1967).

A range telescope consisting of 22 plastic scintillators was constructed to aid in the identification of photoproduced K mesons with energies between 175 and 300 MeV. Extensive use of the correlation between pulse heights helped establish the particle identification. After preselection of a fairly standard nature, pulse heights from 18 scintillators were digitized and punched onto paper tape for subsequent computer analysis. Data from the last few counters were used to establish a range for the particle under a particular mass hypothesis, and it was required that these data represent a reasonable behavior for the stopping particle. Using this range and mass, a parameter similar to χ^2 was then computed from the data from the remaining counters. From the distribution of this variable, backgrounds and efficiencies were estimated. The method permitted a gain of about a hundred in rejection efficiency over pure electronic selection. Various backgrounds, phototube instabilities and computing difficulties limited the technique, but it was successful for this experiment and may have other uses. (auth)

8600 A STABILIZING SYSTEM FOR MAGNETIC SPECTROMETERS BASED ON THE HALL-EFFECT. Lourens, W.; Visser, B. (Laboratorium voor Technische Physica, Delft, Netherlands). Nucl. Instrum. Methods, 46: 275-81(1967).

The Hall-phenomenon is used to stabilize a magnetic spectrometer. Some equations valid for the stabilizer are derived. A description of a field-regulator is given, which system has a stability of 5 parts in 10^5. (auth)

8601 DETECTION EFFICIENCY OF A PLASTIC SCINTILLATOR FOR NEUTRONS BETWEEN 0.2 AND 3 MeV. Honecker, R.; Graessler, H. (Technische Hochschule, Aachen). Nucl. Instrum. Methods, 46: 282-8(1967).

The detection efficiency of a Pilot B plastic scintillator was measured for neutron energies between 0.2 and 3 MeV at a recoil proton energy threshold of 0.19 MeV. In part of the measurements also an upper energy level of the accepted proton recoils has been set. Neutrons in the energy range of interest were produced by scattering D-D- and D-T neutrons from a hydrogen target represented by a plastic scintillator, the pulses of which were used for background reduction. The experimental results were compared with calculated efficiencies and good agreement is obtained for the energy dependence as well as for the absolute values. (auth)

8602 AUTOMATION OF THE MOESSBAUER SPECTROMETER. Bara, Jozef; Janicki, Mieczyslaw (Jagiellonian Univ., Krakow. Inst. of Nuclear Physics, Krakow). Nukleonika, 11: 517-20(1966).

The prototype system was elaborated for automatic measurement of the Mössbauer spectra in the velocity range 0–10 mm/sec. This system changes the velocity of the absorber step by step, and records the number of pulses, the time of measurement, and the values of the velocity. The velocity intervals and number of pulses for each point of measurement can be programmed. (auth)

8603 DESIGN AND PERFORMANCE OF WIRE SPARK CHAMBERS AND MAGNETOSTRICTIVE DELAY LINE READOUT SYSTEM. Perez-Mendez, V. (Univ. of California, Berkeley); Devlin, Th. J.; Solomon, J.; Droege, Th. F. Nucl. Instrum. Methods, 46: 197-207(1967).

A wire spark chamber system is described having magnetostrictive delay line readout that was used in an experiment at the 184 in. Berkeley Synchrocyclotron. The design and performance of the chambers, the electronics used to produce the direct digitization of the spark locations, and the analysis of the digital information are discussed. The spark chamber with 1 mm wire spacing had a spa-

tial resolution of about 0.3 mm. In conjunction with an analyzing magnet forming a magnetic spectrometer, the spark chamber system achieved better than 1% momentum resolution for particles in the range of 200–320 MeV/c. The data analysis was completed within several hours after acquisition, enabling the experimenters to take advantage of the information while the experiment was still in progress. (auth)

8604 PERFORMANCE OF WIRE SPARK CHAMBERS WITH LARGE AREA AND TWO COORDINATE READ-OUT. Galster, S.; Goerres, J.; Hartwig, G.; Klein, H.; Moritz, J.; Schmidt-Parzefall, W.; Schopper, H. (Technische Hochschule, Karlsruhe, Ger. Kernforschungszentrums, Karlsruhe, Ger.). Nucl. Instrum. Methods, 46: 208-12(1967).

Wire spark chambers up to 50×50 cm^2 with a ferrite core storage were built and tested. The difficulties arising from the large capacity of large area chambers were overcome by limiting the spark current and damping its oscillations. The arrangement of the chamber allows also the high voltage electrodes to be used for the determination of a spark coordinate. Thus with crossed ground and high-voltage-electrode wires one chamber gives two coordinates simultaneously. Efficiencies of 98% and spatial resolutions of approximately ±0.3 mm were obtained. Measurements of the sensitive time were also performed. (auth)

8605 CALCULATION OF ANGULAR CORRELATION ATTENUATION FACTORS AND EFFICIENCIES FOR LITHIUM DRIFTED GERMANIUM DETECTORS. Black, J. L.; Gruhle, W. (Stanford Univ., Calif.). Nucl. Instrum. Methods, 46: 213-22 (1967).

Angular correlation attenuation factors and efficiencies were computed for eleven Ge(Li) detectors with sensitive volumes in the range 0.3 cm^3 to 8.0 cm^3. The calculations were carried out for eight source-detector separations in the range 1.0 to 10.0 cm. (auth)

8606 A MINIATURE COOLING SYSTEM FOR Ge(Li) SOLID-STATE DETECTORS. Williamson, C. F.; Alster, J. (Univ. of Washington, Seattle). Nucl. Instrum. Methods, 46: 341-3(1967). (RLO–1388-4).

A cooling system using a Joule-Thompson cryostat is described for the convenient use of a Ge(Li) solid-state detector in a vacuum chamber or in an anticoincidence annulus. (auth)

8607 A NOTE ON THE RELATIONSHIP BETWEEN ENERGY LOSS AND LIGHT OUTPUT FOR PLASTIC SCINTILLATOR NE-102. Groom, D. E.; Hauser, M. G. (California Inst. of Tech., Pasadena). Contract AT(11-1)-68. Nucl. Instrum. Methods, 46: 301-4(1967). (CALT–68-68).

Pulse height spectra in a sandwich of three thick plastic scintillators in which protons stopped with an approximately uniform range distribution were sensitive to the relationship between energy loss and light output. Although the response observed was definitely nonlinear, the saturation was not as extreme as expected. If the relationship between rate of energy loss and rate of light output is taken to be of the form $dL/dx = (C/\alpha)\ln\{1 + \alpha(dE/dx)\}$, then the data are consistent with a value for α between 0.007 and 0.015 $(MeV/g \cdot cm^2)^{-1}$, but are difficult to reconcile with previously published values. (auth)

8608 TEST OF A SPECTROMETER FOR INTENSE NANOSECOND BURSTS OF HIGH ENERGY PARTICLES. Plass, G.; Vahlbruch, K. M.; Wachsmuth, H. W. (CERN, Geneva). Nucl. Instrum. Methods, 46: 233-8(1967).

Tests are reported of a flux spectrometer proposed previously to measure the meson spectrum behind an external target in a fast ejected proton synchrotron beam. The spectrometer consists of a high dispersion small aperture magnet and a Cherenkov detector as a fluxmeter. The measured production of 8–20 GeV/c pions at one degree is consistent with previous measurements. (auth)

8609 PARTICLE FOCUSING FOR A MAGNETIC ANALYZER USING A SPARK CHAMBER. Saudinos, J.; Vallois, G.; Laspalles, C. (CEN, Saclay, France). Nucl. Instrum. Methods, 46: 229-32(1967). (In French).

A spark chamber to localize particles on the focal plane of a magnetic spectrometer is described. The linear resolution over a total range of 22 cm is about 1.5 mm; counting rates up to 100 cps are used without trouble. (auth)

8610 BEAM PROFILE SPARK CHAMBER WITH MAGNETOSTRICTIVE READOUT. Weisberg, H.; Perez-Mendez, V. (Univ. of California, Berkeley). Nucl. Instrum. Methods, 46: 233-7(1967). (UCRL–16704).

The construction and operation of a small spark chamber with magnetostrictive delay-line readout which is useful for measuring the spatial profile of particle beams is described. The beam profiles are accumulated directly in the memory of a multichannel analyzer. The advantages of this beam profile detector are good spatial resolution and accuracy, rapid accumulation of data and convenience of use. (auth)

8611 GENERATION-RECOMBINATION NOISE AND ITS INFLUENCE ON THE ENERGY RESOLUTION OF DIFFUSED SILICON p–n JUNCTION RADIATION DETECTORS. Deshpande, R. Y. (Atomic Energy Establishment, Trombay, India). Nucl. Instrum. Methods, 46: 255-60(1967).

A basic mechanism limiting the energy resolution of p-n junction nuclear radiation detectors is proposed. Shockley-Read-Hall statistics are applied to determine the time constant of the charge-fluctuation at the generation-recombination centers. Some factors governing this time constant are discussed. A specific case of diffused silicon p-n junction detectors, for which information about the generation-recombination centers is available, is then worked out. The charge-fluctuation time constant is used as a normalizing parameter to evaluate the noise-power spectrum of the detector-amplifier system. Finally, some design considerations of the system are presented. (auth)

8612 THE USE OF FOURIER TRANSFORMS IN THE UNFOLDING OF EXPERIMENTAL DATA. Ritchie, R. H.; Anderson, V. E. (Oak Ridge National Lab., Tenn.). Contract W-7405-eng-26. Nucl. Instrum. Methods, 45: 277-81(Dec. 1966). (ORNL-P–2155).

It was shown that when experimental data are subject to smearing effects which may be approximated in convolution integral form, Fourier transform methods used in conjunction with a nonlinear least squares analysis may be of use in recovering the unsmeared data. Application of the method to the unfolding of experimental data in a time-of-flight experiment in gaseous electronics is described. (auth)

8613 FAST-NEUTRON SPECTROMETER FOR REACTOR ENVIRONMENTS. Verbinski, V. V.; Bokhari, M. S. (Oak Ridge National Lab., Tenn.). Contract W-7405-eng-26. Nucl. Instrum. Methods, 46: 309-16(1967). (ORNL-TM–1546).

A fast-neutron spectrometer which can operate in a reactor environment has been tested in the water shield of the Bulk Shielding Reactor I in gamma-ray fluxes as high as 10^6 R/h. Basically, the spectrometer consists of a very thin layer of ^{6}LiF between, but not in contact with, two silicon-gold diodes. Neutrons traversing the spectrometer collimator strike the ^{6}Li foil, and the alpha particle and triton emitted in the resulting ^{6}Li(n,α)T reaction (Q = 4.78 MeV) are detected in coincidence in the two diodes. Shadow shielding in the collimator protects the diodes from direct reactor radiations. Background measurements are made by substituting a ^{7}LiF foil for the sensitive ^{6}LiF element. The measured spectra are in good agreement with calculated spectra, the measurements and calculations having been normalized to the same absolute neutron source intensity. (auth)

8614 DETECTION OF LIGHT NUCLEI WITH CELLULOSE NITRATE. Jones, W. D.; Neidigh, R. V. (Oak Ridge National Lab., Tenn.). Contract W-7405-eng-26. Appl. Phys. Lett., 10: 18-20(Jan. 1, 1967). (ORNL-P–2730).

It was shown experimentally that light nuclei, including protons having energies as low as 55 keV, can produce etchable damage in cellulose nitrate. Comparison of experimental results with theory indicates that the threshold for track registration is about 0.35 MeV per mg-cm^{-2}. (auth)

8615 SENSITIVITY OF A PARAFFIN-MODERATED BF_3 PROPORTIONAL COUNTER. Ryufuku, Hiroshi; Tatsuta, Hatsumi; Shirotani, Takashi (Japan Atomic Energy Research Inst., Tokyo). Jap. J. Appl. Phys., 5: 1039-46(Nov. 1966).

The sensitivity was obtained by solving a multi-group diffusion equation and by an experiment using monoenergetic neutrons. The neutron energies used were over the range of 0.625 eV to 10 MeV in the calculation and 5 keV to 6 MeV in the experiments. Moderator thicknesses were 2.7, 4.7, 6.7, 7.9, 11.0, and 14.7 cm in the calculation, and 3.5, 4.5, 6.5, 8.5, and 14.0 cm in the experiments. The results show a good agreement between the experimental and theoretical sensitivities for the energies above 200 keV, while slight discrepancies appear below this energy. (auth)

8616 AN AUTOMATIC SAMPLE CHANGER WITH A SPECIAL CHANGING METHOD FOR γ– AND γ-γ–ACTIVE SOURCES. Blank, K. H.; Seufert, H. (Kernforschungszentrum, Karlsruhe, Germ.). Nucl. Instrum. Methods, 46: 86-92(1967).

An automatic sample changer is described which permits direct comparison of the relative activation of samples simultaneously irradiated in a reactor without the need for decay time corrections of the measured results. The turntable of the sample changer may be loaded with 2 to a maximum of 90 γ-active solid samples for single and coincidence measurements. Special care was taken to achieve accurate positioning of the samples in the measuring position. The mechanical drive of the sample changer is pneumatic and the electronic control acts upon electropneumatic valves. It is

possible to operate the sample changer for any number of samples within the set limits without changing the control electronics. The data are read out as a group of n numbers by a printer and/or tape punching device. The first two numbers represent the address of the data, and the following n − 2 numbers the result of the measurement. (auth)

8617 MEASURING SOLAR X-RAY EMISSION WITH SATELLITE-BORNE INSTRUMENTS. Vasil'ev, B. N. Kosm. Issled., 4: 748-54(Sept.-Oct. 1966). (In Russian).

The instrumentation carried by the Elektron-2 and Elektron-4 satellites to measure solar x-ray emission in the 2 to 10 Å and 8 to 18 Å spectral regions is described. The entire system consisted of two blocks of separate counters mounted externally, and a block of radio electronic equipment located inside the satellite. The main block of counters was placed on a self-orientation system (toward the Sun). The optical axis of the second block, which was rigidly attached to the satellite surface, coincided with the dead zone center of the main block. The viewing angle of the second block was ±30°. Geiger photon counters with 25-mg/cm^2 beryllium windows, sensitive in the 2 to 8 Å region, and Geiger counters with 2.7-mg/cm^2 aluminum windows, sensitive in the 8 to 18 Å region, were used to record the x-ray emission. Other aluminum counters, additionally shielded with thin gold or silver foil, were employed as control counters in each of the two blocks. The control counters, which were only slightly sensitive to the soft x-ray emission, measured the level of noise caused by particles from radiation belts. Silicon phototransducers kept the Sun in the field of view of the two blocks of photon counters. Pulses from similar counters were directed to a common measuring channel. The pulse repetition frequency was approximately proportional to the emission intensity. The parameters of the counters remained unchanged after 10^{10} pulses were recorded and after operation at temperatures from −40 to +50°C. The radioelectronic section of the system included three identical channels for measuring the pulse repetition rate from the x-ray photon counters, a phototransducer signal indication channel, a reset unit, and a stabilized power supply block. The section operated normally at temperatures ranging from −10 to +40°C with variation in the supply voltage from 12 to 18 V. The pulse counting rate was recorded with an accuracy of ±(15 to 17%). (ATD)

8618 WIDE-RANGE COUNT RATE METER UTILIZING PLURAL COUNT RATE CIRCUITS AND A RANGE IDENTIFIER. Thomas, Stanley W. (to U. S. Atomic Energy Commission). U. S. Patent 3,300,719. Jan. 24, 1967.

An improved count rate meter providing fast pulse-repetition frequency measurements over a large range is described. Essentially, the invention makes use of a single binary circuit to drive a plurality of count rate circuits. Each count rate circuit measures the pulse-repetition frequency over a portion of the desired range. Gating circuitry is used to provide switching modes between the count rate circuits. The switching modes determine, from the input pulse-repetition frequency, which of the count rate circuits is capable of measuring that range of the pulse-repetition rate and accordingly gates that count rate circuit into an on state and the other circuits into off states. Two output channels are provided. One channel measures the pulse-repetition rate and the other channel designates the on and off states of the counting circuits. (AEC)

8619 IMPROVEMENTS IN OR RELATING TO IONIZATION CHAMBERS. (to Gesellschaft zur Foerderung der Forschung an der Eidgenoessischen Technischen Hochschule). British Patent 1,050,273. Dec. 7, 1966. Priority date Mar. 1, 1963, Switzerland.

An invention is described which relates to an improved method for gamma compensation of an ionization chamber measuring neutron flux, particularly in a nuclear reactor. (B.G.D.)

8620 ISOTROPIC NEUTRON DOSIMETER (Engineering Materials). (Oak Ridge National Lab., Tenn.). (CAPE-1498).

2 drawings.

The BF_3 proportional counter is used as an isotropic multicollision fast neutron dosimeter. A spherical copper cathode is used to obtain equal sensitivity in all directions. The anode consists of 2 perpendicular ½-in. dia loops fabricated from 0.002-in. dia tungsten wire. Loops are held concentric with the cathode by a 0.050-in. dia stainless steel capillary tube. (For details see TID-4100 Suppl. 37.) (F.S.)

8621 PPC III MULTISECTION ION CHAMBER (Engineering Materials). (Oak Ridge National Lab., Tenn.). (CAPE-1527).

97 drawings.

The PPC III (parallel plate chamber), an improved version of the PPC II (see CAPE-1169), is a more rugged instrument and can be manufactured at lower cost. The multisection ionization chamber is used for reactor control of high-performance research and power reactors. Emphasis in design is on reliable performance. The chamber and connecting cables are designed to operate for a minimum of 5 yr without failure from radiation damage. Electrodes are coated with ^{10}B for use as a neutron-sensitive chamber, with ^{235}U for use as a fission chamber, or left uncoated for use as a gamma-sensitive chamber, and for a gamma-compensated neutron-sensitive chamber. Boron-coated and uncoated electrodes (appropriately coated and connected) are used. (For details see TID-4100 Suppl. 38.) (F.S.)

8622 PORTABLE AIR MONITOR (Engineering Drawings). (California Univ., Livermore). (CAPE-1526).

58 drawings.

A portable monitoring system continuously monitors the atmosphere for beta emitting isotopes in remote areas where ac power is not available. The system is battery powered, small and lightweight, and can operate continuously for 8 hours. The electronics is transistorized on printed circuit boards. An alarm trip circuit can be set at predetermined levels above background. Interference from concentrations of 300 pc/m^3 of radon-thoron daughter products has been considered and found to have little effect when compared to MPC quantities of ^{131}I. Using charcoal impregnated, glass-fibre filter paper, the monitor can detect 1 MPC of ^{131}I in about 10 minutes. (F.S.)

8623 LOW LEVEL NEUTRON COUNTER (Engineering Materials). (Savannah River Lab., E. I. du Pont de Nemours and Co., Aiken, S. C.). (CAPE-1525).

5 drawings.

A neutron counting system is described for use in determining ^{252}Cf and Cm nuclides which has very sensitive BF_3 detectors providing detection limits of ~0.13 μg for ^{244}Cm or ^{246}Cm, 0.04 μg for ^{248}Cm and 0.63 μg for ^{252}Cf on the basis of specific neutron activity from spontaneous fission. A supplementary portable 7 in. shield of paraffin saturated with boric acid is installed and by moving the counter farther from the samples, background is greatly reduced. (For details see TID-4100 Suppl. 38.) (F.S.)

Radiation Dosimeters

8624 (AECL-2629) THE DESIGN AND USES OF A MINIATURE RECORDING γ-RAY DOSIMETER. Jones, A. R. (Atomic Energy of Canada Ltd., Chalk River (Ontario)). July 1966. 20p. Dep. mn. AECL $0.50.

The evolution of design of a miniature recording γ-ray dosimeter, its performance, and application is described. The dosimeter comprises: a regulated high voltage supply, a low sensitivity GM counter, an electrostatic scaler, a miniature wrist-watch counter, and means for controlling power taken by the high voltage supply and checking the state of the battery. It measures doses to the wearer in the range 4 mrad–432 rad at rates from 1 mrad/h–100 rad/h. The battery lasts for at least three months. The dosimeter fits into a shirt pocket. (auth)

8625 (SGAE-CH-40/1966) DIE VERWENDUNG VON FLUORKOHLENSTOFFEN ZUR CHEMISCHEN DOSIMETRIE IM KERNREAKTORSTRAHLUNGSFELD. (The Use of Fluorocarbons for Chemical Dosimetry in Nuclear Reactor Radiation Fields). Proksch, E.; Slais, E. (Oesterreichische Studiengesellschaft fuer Atomenergie G.m.b.H., Seibersdorf. Institut fuer Chemie). 1966. 7p. (In German). (CONF-660614-8). Dep. mn.

From 3rd International Congress on Radiation Research, Cortina, Italy.

A proposal is made for using the formation of CF_4 from suitable fluorocarbons combined with the H_2-production from cyclohexane for the simultaneous determination of gamma and fast neutron doses. Both measurements may be easily performed by gas chromatography. An examples, two commercial "Perfluorokerosene" mixtures have been investigated first. After purification, both mixtures show $G(CF_4)$-values which are sufficiently reproducible but slightly dependent on dose. When used for in-pile dosimetry, satisfactory agreement was found with calorimetry. (auth)

8626 (UCRL-16924) LITHIUM-DRIFTED SILICON DETECTOR USED AS A PULSE DOSIMETER. Raju, Mudundi R.; Lampo, Edward J.; Curtis, Stanley B.; Sperinde, Johnie M.; Richman, Chaim (California Univ., Berkeley. Lawrence Radiation Lab.). Sept. 27, 1966. Contract W-7405-eng-48. 10p. (CONF-661020-15). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

From 13th Annual Nuclear Science Symposium, Boston, Mass.

A lithium-drifted silicon detector used as a pulse radiation dosimeter is described. It is used to measure the depth-dose distribution of pion beams in water. The fractional dose due to energy depositions above a particular energy in the detector can also be measured. Such measurements yield information on the distribution of ionization density. Preliminary results of the pion-beam dosimetry using this pulse dosimeter are given. (auth)

8627 DOSIMETER FOR X-RAYS AND GAMMA RAYS. Schayes, Raymond Georges (to Manufacture Belge de Lampes et de Materiel Electronique). U. S. Patent 3,283,150. Nov. 1, 1966. Priority date Nov. 29, 1962, Belgium.

An improved thermoluminescent dosimeter is described which is used in x- and gamma-ray dosage measurements. The dosimeter consists of a hollow cylindrical support of nickel or ceramic material covered on its outer surface with calcium fluoride or other thermoluminescent material which fluoresces upon heating after irradiation, and a heater in the form of a helix of a thin wire of constant pitch which heats the thermoluminescent material by conduction. (F.S.)

8628 RADON DOSIMETER. Geiger, Eric L. (to Eberline Instrument Corp.). U. S. Patent 3,283,153. Nov. 1, 1966. Filed July 2, 1963.

The design of a dosimeter to be worn by miners to detect radon and radon daughters is described. In an exposure to radon, a portion of the radon diffuses into a central cavity of the dosimeter. On disintegration of the radon polonium is formed and alpha particles with kinetic energy. Polonium atoms deposited on the surface of the inner cavity disintegrate by emitting alpha particles. Some alpha particles pass through a Mylar window into an alpha sensitive film emulsion producing alpha tracks which can later be observed with a microscope. The tracks indicate a miner's exposure to the hazard of radon and its daughter products. (F.S.)

8629 TRANSPARENT INTENSIFIER FOILS FOR USE WITH PHOTOGRAPHIC MATERIALS FOR RECORDING X-RAYS, γ-RAYS OR CORPUSCULAR RAYS. Blank, Rudolf; Matejec, Reinhart; Rause, Roderich (to Agfa Aktiengesellschaft). U. S. Patent 3,282,697. Nov. 1, 1966. Priority date Oct. 17, 1961, Germany.

Transparent intensifier foils for photographic materials to record high energy gamma and x rays are described. The photographic materials consist of at least one silver halide emulsion layer sensitive to high energy radiations in contact with a transparent foil of a film-forming polymer which contains benzene rings. The polymer may be polystyrene, polyesters, polyvinyl toluene, polydiphenyl butadienes, polytetraphenyl butadienes or polydiphenyl hexatrienes. An organic fluorescent compound is added to convert the high energy radiation into light having a wave length of between 200 to 600 mμ. The organic fluorescent material may be coumarines, benzthiophene dioxides, or benzoxazols. The photographic material has dissolved in it metal salts of carboxylic acid, a tin salt of an aliphatic carboxylic acid, or an organic tin compound. (F.S.)

Radiometric Instruments

Refer also to abstracts 8532, 8533, and 8544.

8630 (MIT-952-3, pp 349-402) INSTRUMENTATION TECHNIQUES AND NUCLEAR GEOCHEMISTRY. (Massachusetts Inst. of Tech., Cambridge. Dept. of Physics).

The following instrumentation techniques are described: low-noise charge-sensitive preamplifiers for semiconductor detectors; data processing; electronic equipment for alpha-gamma coincidence spectroscopy; automatic alpha-gamma angular correlation apparatus; ^{227}Ac thin source preparation; and contoured diffused-junction detectors. The following studies in nuclear geochemistry are reported: three-dimensional electrical analog studies of pressure-induced interstitial flow in underground mine environments and the application of lithium-drifted germanium detectors to neutron activation analysis. (H.L.W.)

8631 ADAPTATION OF GAUGES WITH RADIOACTIVE SOURCES OF TRITIUM FOR THE PRECISE MEASUREMENT OF THE VAPOR PRESSURE OF PURE WATER. Armas, B.; Blanc, D.; Dagnac, R. (Centre de Physique Atomique et Nucleaire, Toulouse). Vide, 21: 399-401(Sept.-Oct. 1966). (In French).

Many of the customary gages do not enable one to measure water vapor pressures; however, the gages making use of the ionization created by a radioactive source are adaptable to such a problem: A prototype with a tritium source which makes it possible to determine the pressure of pure water vapor, from 10^{-4} to one torr, with an accuracy better than 5% was realized. This apparatus is intended to equip the charge exchange chamber of the neutral atoms generators "EOLION" made by C.S.F. (auth)

8632 UNIFORMITY OF METAL FOILS. Ramirez, J. J.; Quinton, A. R. (Univ. of Florida, Gainesville). Nucl. Instrum. Methods, 45: 353-4(Dec. 1966).

An initially monoenergetic beam of particles passing through matter experiences an energy broadening due to energy straggling and target nonuniformity. An experiment is described which measures the energy broadening due only to thickness irregularities and provides a method of assessing the uniformity of foils. (B.G.D.)

8633 UNDERWATER NEUTRON RADIOGRAPHY WITH CONICAL COLLIMATOR. Barton, J. P.; Perves, J. P. (Univ. of Grenoble, France). Brit J. Non-Destruct. Testing, 8: 79-83 (Dec. 1966).

An apparatus for neutron radiography which has been put in operation at the 4 MW pool reactor Melusine at Grenoble is described. The design incorporates two special features: radiographic examination of highly radioactive objects irradiated within the reactor core without their being at any time extracted from the adequate depth of shielding water, and a funnel-shaped neutron collimator which combines the advantages of very high picture definition with large picture frame size and absence of lines characteristic of multi-slit collimators. (auth)

8634 MEANS FOR DETERMINING FLUID INTERFACE IN UNDERGROUND STORAGE SPACE. Clark, Ernest L. (to Phillips Petroleum Co.). U. S. Patent 3,284,630. Nov. 8, 1966. Filed May 7, 1963.

A method and the equipment used to determine the interface between two fluids in a storage space without opening the storage space are described. The apparatus, a logging probe, consists of a ^{137}Cs gamma source, a Geiger-Mueller detector, a means to convert low voltage electric power to high voltage power, a cable, cable reel, depth indicator, signal light, count rate meter, recorder for the count rate meter, and a relay. (F.S.)

8635 MUD-CAKE-THICKNESS MEASURING DEVICE FOR GAMMA-GAMMA DENSITY LOGGER. Baker, Paul E.; Yule, Herbert P.; Jones, Stanley B. (to Chevron Research Co.). U. S. Patent 3,281,599. Oct. 25, 1966. Filed Aug. 25, 1959.

In density logging by γ irradiation of an earth formation and detection of back scattered γ radiation, an apparatus or feeler is adapted to ride the side of the well bore to detect caving and irregularities in the well bore directly in the path between the source and the detector. The feeler is interposed between the source and the detector biased toward the side of the bore hole so that its outer end includes a knife edge adapted to penetrate the mud-cake and directly contact the rock forming the side of the well bore. Means are provided for measuring the deflection of the outer end of the feeler relative to the body position of the lagging sonde. (F.S.)

Miscellaneous Instruments and Components

Refer also to abstracts 8562, 9159, 9160, 9481, 9648, and 10131.

8636 (AERE-R-4060) AN ANEROID BOMB CALORIMETER FOR MEASURING THE HEAT OF COMBUSTION OF IRRADIATED NUCLEAR GRAPHITE: PRELIMINARY EXPERIMENTS IN AN OBSERVATION BOMB. Lewis, J. B.; Phillips, R. H. (Atomic Energy Research Establishment, Harwell (England)). July 1966. 26p. Dep. mn. BIS $0.80. HMSO 4s.

An aneroid bomb calorimeter is described in which the heat of combustion of irradiated graphite can be measured more conveniently and accurately than previously. An accuracy of about 1 part in 10,000 is obtainable. Preliminary investigations were carried out in a specially designed observation bomb to determine the best techniques to be used when burning graphite in the aneroid calorimeter. The construction of this bomb, which is fitted with two windows, is described. Experiments showed that a satisfactory determination of the amount of graphite burned could be obtained from the difference between the original mass and the weight of combustible residue. (auth)

8637 (AERE-R-5306) DATA LOGGING BY SMALL COMPUTER. MacLennan, D. N. (Atomic Energy Research Establishment, Harwell (England)). Nov. 1966. 28p. Dep. BIS $0.80. HMSO 4s. 0d.

An experimental system is described in which a PDP-8 Computer is used to log the output data from four on-line thermocouples. The extension of the system to at least 150 thermocouples or other transducers is discussed. (auth)

8638 (BAW-1280-41) HIGH TEMPERATURE STRAIN GAGES FOR USE IN SODIUM ENVIRONMENTS. Research Report No. 5138. Rastogi, V. (Babcock and Wilcox Co., Alliance, Ohio. Research Center). Dec. 20, 1966. Contract AT(11-1)-1280. 30p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The selection of and techniques for using high temperature strain gages in equipment like the B & W prototype sodium-heated steam generator are discussed. (B.G.D.)

8639 (EUR-3176.e) A MASS-SPECTRUM-DIGITIZER FOR THE ATLAS TYPE CH-4 MASS-SPECTROMETER. Mol, M. J. (European Atomic Energy Community, Ispra (Italy). Joint Nuclear Research Center). Oct. 21, 1966. 48p. Dep. mn.

To reduce the time required for the interpretation of mass-spectra obtained with the Atlas type CH-4 spectrometer a mass-spectrum digitizer was constructed, that automatically prints the spectral information in digital form. The characteristics of the spectrometer output signals and the design principle based on these signals are described. The results of tests performed under different operating conditions of the spectrometer are given. (auth)

8640 (IDO-17211) INSTRUMENT DEVELOPMENT BRANCH ANNUAL REPORT, 1965. Wilde, N.; Boland, T. J.; Anderson, S. D. (Phillips Petroleum Co., Idaho Falls, Idaho. Atomic Energy Div.). Sept. 1966. Contract AT(10-1)-205. 254p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The major projects carried out by the Instrument Development Branch are reported. Topics discussed are detector and transducer development, measuring and testing techniques, fuel element development, Idaho Chemical Processing Plant instrumentation, health physics instrumentation, counting room instrumentation, test reactor control and safety instrumentation, zero power reactor control and safety instrumentation, nuclear safety technology, and analog and digital computer simulation. (B.G.D.)

8641 (TID-23478) DIGITAL CABLE LENGTH MEASURING SYSTEM. Technical Memorandum L-44. Hansen, Ramon D. (Edgerton, Germeshausen and Grier, Inc., Las Vegas, Nev.). Aug. 30, 1962. Contract AT(29-1)-1183. 10p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

A cable length measuring system is discussed which includes a trigger circuit, an avalanche transistor circuit that oscillates at a frequency determined by the length of the cable being measured, and a digital frequency counter to record the oscillation frequency. The theory of the system, including the circuitry involved, is discussed along with its measurement capability and accuracy. (auth)

8642 (UCRL-16838) INTEGRATING WINDOW AMPLIFIER. Goldsworthy, William W. (California Univ., Berkeley. Lawrence Radiation Lab.). Oct. 4, 1966. Contract W-7405-eng-48. 20p. (CONF-661020-13). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

From 13th Annual Nuclear Science Symposium, Boston, Mass.

A pulse-measuring technique, in which pulses are measured on the basis of area rather than amplitude, is employed in the design of a pulse window amplifier. This pulse-area-integration technique is used primarily to improve linearity, reduce resolution degradation resulting from rise-time jitter, and simplify amplifier drive requirements. (auth)

8643 NUCLEAR AND REACTOR PHYSICS EXPERIMENTS WITH AN ON-LINE COMPUTER. Allen, B. J.; Bird, J. R. (Australian Atomic Energy Commission). At. Energ. Austral., 9: No. 3, 6-13(July 1966).

Data processing systems have been developed for use with sophisticated pulse height analyzers. The PDP-7 Programmed Data Processor in the Physics Division at Lucas Heights offers superior flexibility, and its operation and coupling to experiments are described. Some current and proposed experiments (single-parameter, multiparameter, multiscaling, and correlation) are described, to illustrate the versatility of the on-line computer. (D.L.C.)

8644 CALCULATION OF SCINTILLATION SPECTRUM DISTORTION AS A RESULT OF PULSE SUPERPOSITION. Zaitseva, A. M.; Soshin, L. D.; Selaninov, Yu. E. Zh. Prikl. Spektrosk. Akad. Naus BSSR, 5: 537-9(Oct. 1966). (In Russian).

A calculation was made of errors in pulse counting due to the superposition of two pulses. The case is of small probability at low intensities but becomes more and more probable with the intensity increase. (auth)

8645 COMPARATIVE TESTS OF EMULSIONS SENSITIVE TO SPARK MASS SPECTROMETRY. Cavard, Andre; Stefani, Rene; Bourguillot, Robert (CEA, Grenoble, France). Compt. Rend., Ser. B, 263: 928-31(Oct. 17, 1966). (In French).

The ion sensitivities of a classical Ilford Q 2 emulsion and of a special emulsion, type Kodak SC 5, with very thin gelatin thickness, were compared. The Kodak emulsion gives a significant sensitivity gain, improves the resolution of the rays, and strongly lowers the detection limits in analysis, which becomes of the order of one part per million. The mass effect of the ions on the sensitivity is discussed. (tr-auth)

8646 ION-SENSITIVE PROBE: NEW DIAGNOSTIC METHOD FOR PLASMAS IN MAGNETIC FIELDS. Katsumata, Itsuo; Okazaki, Moroe (Osaka City Univ.). Jap. J. Appl. Phys., 6: 123-4(Jan. 1967).

The new probe is briefly described. A brief summary of the performance of the probe is included. (M.O.W.)

8647 LIQUID HELIUM COOLED STAGE FOR AN ELECTRON MICROSCOPE. Watanabe, Hiroshi; Ishikawa, Isao (Hitachi, Ltd., Tokyo). Jap. J. Appl. Phys., 6: 83-8(Jan. 1967).

A liquid helium cooled stage for an electron microscope has been constructed. Liquid helium flows through a thin copper pipe around the specimen holder. The flexible pipe allows the specimen movement for observation. The holder and pipe are enclosed in a shield case which is kept nearly at liquid nitrogen temperature. The specimen temperature is controlled by the flow of helium, and is measured with an Au + Co-chromel thermo-element attached to the stage. The specimen can be exchanged by means of a usual mechanism without breaking the column vacuum. Observation of magnetic effect in a superconducting film is described. In a defocused image of Nb_3Sn film the beam deflection due to the magnetic field pushed out of the film below the transition temperature was observed. The inhomogeneity of the mixed state of a niobium film appeared as a zig-zag edge in the defocused image. The relaxation of the magnetic flux frozen in Nb_3Sn film was recorded on a 16 mm cine-film. (auth)

8648 TIME-TO-AMPLITUDE CONVERTER FOR THE MEASUREMENTS OF NANOSECOND ISOMERS. Jastrzebski, Jerzy; Moszynski, Marek; Zglinski, Antoni (Inst. of Nuclear Research, Swierk, Poland). Nukleonika, 11: 471-90(1966).

The construction and adjustments of a time-to-amplitude converter based on the pulse overlap principle is described. The converter is linear in 30 ns range and the best resolving time is 350 ps. The apparatus is equipped with pile up rejection circuit and pulse height compensation. The instrumental time delay was investigated with and without pulse height compensation. This converter was used for the determination of the lifetimes of some nanosecond isomers in nuclei from the deformed and transition region. (auth)

8649 HIGH-AMPLIFICATION PHOTOMULTIPLIER DIVIDER SUPPLY. Moszynski, Marek (Inst. of Nuclear Research, Swierk, Poland). Nukleonika, 11: 491-501(1966).

The question of photomultiplier divider load with current flowing through the photomultiplier and amplification changes connected with it are dealt with. Admissible count intensity of scintillators NaI(Tl) and stilbene were estimated. Various methods of high amplification (10^8) photomultiplier divider supply were surveyed. A method of type 56AVP photomultiplier divider supply from two voltage sources and a simple feeder of the high current part of the divider was described. The important parameters are: voltage adjustable in 500 to 1000 V range, current output 30 mA, long-time stability better than $\pm 2.3 \times 10^{-4}$ per 8 hr without preliminary stabilization of the mains. (auth)

8650 ON-LINE COMPUTER CONTROLLED AUTOMATIC SAMPLE CHANGER FOR USE WITH A TOTAL GAMMA ABSORPTION TANK. Fullwood, R. R.; Steadman, B. L.; Lewis, J. F. (Rensselaer Polytechnic Inst., Troy, N. Y.). Contract AT(30-3)-328. Nucl. Instrum. Methods, 46: 194-6(1967). (RPI-328-54).

An automatic sample changer is described that selects a sample under computer control and inserts it through 34 in. of travel inside of a 1.25 m dia. neutron capture gamma ray total absorption tank. (auth)

8651 ON THE SUBJECT OF SYMMETRY DEFECTS IN THE MEASUREMENT OF POLARIZATION. IV. GENERAL DISCUSSION OF METHODS OF MEASURING POLARIZATION USING A PRECESSION MAGNETIC FIELD. Libert, J. (Centre de la Faculte Polytechnique, Bergen). Nucl. Instrum. Methods, 46: 238-40(1967). (In French).

A general way of accounting for the influence of symmetry defects on the polarization determination is presented here for the methods of measurement using a precession magnetic field. These methods are discussed and their properties are established rigorously. (auth)

8652 EFFECTS OF LAST DYNODE CAPACITY IN SPACE CHARGE SATURATION TYPE PULSE SHAPE DISCRIMINATOR. Hiramoto, T.; Noda, Y.; Mizutani, T. (National Inst. of Radiological Sciences, Chiba, Japan). Nucl. Instrum. Methods, 46: 261-5(1967).

The effects of the last dynode capacity on the performance of the n-γ discrimination system were studied with a 56AVP using a stilbene crystal. The capacity affected seriously the relation between the amplitude of the discriminating signal and the linear pulse amplitude. With the additional time discrimination as described by Bachelor, the dynamic range of the system could be further extended by adding a capacitor in the last dynode circuit. (auth)

8653 SOLID-STATE ERROR DETECTOR FOR NUCLEAR REACTOR AUTOMATION. Kaniewski, Jacek (Inst. of Nuclear Research, Swierk, Poland). Nukleonika, 11: 593-604(1966).

A single core high speed magnetic amplifier with pulse excitation coupled with dc transistor amplifier was developed for the

experimental nuclear reactor control system as a summing unit (error detector). Some steady-state theory of the magnetic part and results of experiments performed on the prototype amplifier are presented. (auth)

8654 FAST DIGITAL OUTPUT OF A MULTICHANNEL ANALYZER. Dilcher, H.; Hochweller, G.; Zimmermann, W. (Univ. of Marburg, Ger.). Nucl. Instrum. Methods, 46: 344-9 (1967).

A modification of the readout-circuit for two-parameter multichannel analyzers was designed. The normal high velocity readout program of the analyzer (Nuclear Data–ND 150)—i.e., analog display on CRT-screen—will be automatically changed into a (slower) digital readout program in only those channels in which one or more events have been collected. This modification is useful in applications with low counting-rates since it prevents digital readout of zero-information and thus saves paper and time in handling the data. A minor addition to the modified circuits permits digital readout of only those channels which contain numbers of events greater than a preselected level (e.g., $c_n > 9$, 99, 999,...), thus quickly allowing digital determination of peak locations. (auth)

8655 FAST PULSE AMPLIFIER (Engineering Materials). (Oak Ridge National Lab., Tenn.). (CAPE–1470).

1 drawing.

A nanosecond high-gain pulse amplifier with a rise time of 1 nsec at a current gain of 270 is used with an accelerator beam probe and connected with 150 ft of high quality coaxial cable. The amplifier is also suitable for application with semiconductor detectors and fast ionization chambers. (For details see TID-4100 Suppl. 38.) (F.S.)

8656 ION OPTICS OF THE MASS SPECTROMETER ION SOURCE. Naidu, Prabhakar Satyanarayan. Vancouver, B. C., Univ. of British Columbia, 1965.

Thesis.

The ion beam transmission efficiency of the ion source is an important factor in determining the sensitivity of a mass spectrometer. Vauthier (1955) has shown for a simple source that the transmission efficiency is very low. The transmission efficiency of a more complex source is examined. The first part of the thesis deals with the ion optical properties of a multiple-slit ion source. The region of ion withdrawal was sketched by computing the ion trajectories passing through the exit slit. It was found that for the more complex source the region of ion withdrawal is also much smaller than the total ionization space. It is not practical to confine the ionization region to the small volume from which ions are withdrawn. The effect of a source magnetic field was taken into account. The perturbation of the trajectory due to the field is small, and therefore the mass discrimination due to the source magnetic field is imperceptible for heavy ions unless the field is of the order of a few webers/m^2. The multiple slit ion source produces a divergent ion beam, only a small fraction of which penetrates the exit slit. Obviously a system producing a beam converging at the exit slit to a narrow parallel ribbon will be most efficient. In order to devise such a system a theory of the inverse problem of particle motion is developed in the second part of the thesis. A procedure was found to determine a potential distribution required to guide a group of particles along a set of prescribed paths. There are two important limitations to the choice of paths: There are certain paths which are not complete; that is a particle following such a path is turned back at certain points which we call mirror points. The particles which do not satisfy the initial conditions of uniform energy and direction may deviate considerably from their projected paths leading to what is called an unstable situation. Fortunately the complete paths are stable, and the incomplete paths are unstable. Of the two types of convergent paths studied, namely, exponentially decreasing and damped oscillatory paths, the system of damped oscillatory paths is stable. (auth)

8657 HIGH VOLTAGE POWER SUPPLY /Q-2812/ (Engineering Materials). (Oak Ridge National Lab., Tenn.). (CAPE–1496).

1 drawing.

A high voltage power supply was designed for electron beam heating. The power supply has low ripple voltage, adequate safety interlocks, controlled source impedance and a reasonable cost. (For details see TID-4100 Suppl. 38.) (F.S.)

8658 LASER INTERFEROMETERS (Engineering Materials). (Union Carbide Corp., Oak Ridge, Tenn. Y-12 Plant). (CAPE–1504).

2 drawings.

To remove the effects of lead-screw growth and certain other inaccuracies in the feedback system in contour machining, laser interferometers were developed and installed on turning machines. This system has an interferometer on each slide, each of which uses a He–Ne laser with a wavelength of 6328 Å. The interferometer and an amplifier are contained in a very small package. The sinusoidal output of the photo transistors (used as the light-sensitive elements in the interferometer) in conjunction with the high-speed bidirectional counters produce pulses compatible with the existing control unit. Electronic components for the interferometer system are mounted in the original control unit with the exception of the laser power units. The interferometer produces a pulse for every 12.4572 microinches of slide movement; the original machine used 20 microinch pulses. Performance of the system is good. Vibration from spindle rotation and metal removal have virtually no effect on the interferometer and contour accuracies of 50 microinches have been obtained. (For details see TID-4100 Suppl. 37.) (F.S.)

8659 FET PREAMPLIFIER (Engineering Drawings). (California Univ., Livermore). (CAPE-1523).

1 drawing.

The low-noise preamplifier described is charge-sensitive and switch selectable. The input is negative and the output of 5V max is fed into a 50 Ω resistor. Pulse decay time constant is ~100 μsec. The rise time is ~45 ns. The preamplifier will operate at a max ambient temperature of 60°C. The preamplifier chassis is mounted directly over the vacuum feed-through to avoid noise pickup in interconnecting cables. (For details see TID-4100 Suppl. 38.) (F.S.)

8660 X-RAY PROGRAM CONTROLLER (Engineering Materials). (Du Pont de Nemours (E. I.) and Co., Aiken, S. C. Savannah River Lab.). (CAPE–1508).

36 drawings.

A controller which utilizes punched tape to control the scanning function of a goniometer on the x-ray diffractometer is described. It moves the goniometer at a slow scanning speed through the portions of the diffraction pattern under observation. Portions of the pattern not under observation are scanned at a fast goniometer speed. A tape is punched to provide the necessary control functions. The controller is used with a Norelco x-ray diffractometer. The instrument consists of a dual speed drive unit used to move the goniometer and electronic control circuits that provide speed selection and data accumulation. (For details see TID-4100 Suppl. 37.) (F.S.)

Radiation Effects on Instruments and Instrument Components

8661 (N–66-23672) COMPONENTS IRRADIATION TEST NO. 17: RESISTANCE THERMOMETERS AT LIQUID HYDROGEN TEMPERATURES. (Lockheed-Georgia Co., Marietta). Nov. 1965. Contract NAS8-5332. 49p. (NASA-CR–74358; ER–8295). CFSTI $3.00 cy, $0.65 mn.

Two specimens each of one platinum and three carbon resistance thermometers were subjected to a nuclear radiation environment while immersed in liquid hydrogen (temperatures of 20 to 23°K). With a combined radiation dose of 1×10^{15} n/cm^2 and 2.3×10^7 r, there was no significant effect on the temperature indication by the platinum thermometers whereas the temperature indication of the carbon thermometers changed as much as two degrees. It was concluded that the carbon resistance thermometers could withstand combined radiation doses of about 4×10^{13} n/cm^2 and 4×10^5 r at liquid hydrogen temperatures without sustaining significant damage. (STAR)

8662 INVESTIGATION OF THE INFLUENCE OF NEUTRON AND γ IRRADIATION ON THE OPTICAL DENSITY OF GLASSES OF SOME PHOTOMULTIPLIERS. Yushkevich, G. F.; Soshina, N. V. Zh. Prikl. Spektrosk. Akad. Nauk BSSR, 5: 486-8(Oct. 1966). (In Russian).

An investigation was made of the change of the optical density of glasses used for photomultipliers (FEU-13, FEU-14, FEU-52, FEU-56) under neutron and γ irradiation. The change of the optical density increases nonlinearly with the increase of the irradiation dose. The neutron irradiated glasses get dark irregularly. The heating of the irradiated glasses can not restore their transmittance completely. (auth)

8663 EFFECTS OF TRAPPED RADIATION ON ELECTRONIC DEVICES. Brown, W. L. (Bell Telephone Labs., Inc., Murray Hill, N. J.). pp 757-92 of Radiation Trapped in the Earth's Magnetic Field. McCormac, Billy M. (ed.). New York, Gordon and Breach Science Publishers, 1966.

The consequences of the geophysics of the magnetically trapped radiation, together with the solid-state physics of materials and devices, to the hardware of unmanned vehicles in space are considered. The different classes of important radiation effects are

discussed, and their effects on semiconductor devices are considered. Information is included on the Telstar satellite experiments. (J.H.M.)

8664 RADIATION DAMAGE TO ORBITING SOLAR CELLS AND TRANSISTORS. Fischell, R. E.; Martin, J. H.; Radford, W. E.; Allen, W. E. (Johns Hopkins Univ., Silver Spring, Md.). pp 793-807 of Radiation Trapped in the Earth's Magnetic Field. McCormac, Billy M. (ed.). New York, Gordon and Breach Science Publishers, 1966.

In-flight test results from degradation experiments on solar cell and transistors flown on satellites during a time period both before and after Operation Starfish are presented. Some interpretations of the radiation belt contents and effects of solar cell shielding are discussed. (J.H.M.)

8665 DECREASE OF BUILT-IN VOLTAGE IN TUNNEL DIODES CAUSED BY IRRADIATION. Wada, Takao; Nakamura, Toshio; Maruyama, Azusa; Fukuoka, Yutaka; Arizumi, Tetsuya (Nagoya Univ., Japan). Jap. J. Appl. Phys., 6: 71-6(Jan. 1967).

When a germanium tunnel diode is irradiated by 7.2-MeV electrons with a total flux of $\sim 4.6 \times 10^{17}$ electrons/cm^2, the capacitance built-in voltage v_b decreases with the increase in bombardment dose. The variation of the Fermi level obtained from the change in v_b is about 0.040 eV for the total flux. Considering that the carrier concentration of a heavily doped n-type germanium decreases with the electron irradiation, the Fermi level changes only in the n-side of the tunnel diodes. This calculated variation of the Fermi level in the n-side caused by the carrier removal is in good agreement with the above result. (auth)

8666 INVESTIGATION OF THE RADIATION RESISTANCE OF SILICON PHOTOCONVERTERS (ACCORDING TO EXPERIMENTAL DATA OBTAINED BY THE ELECTRON-3 ARTIFICIAL EARTH SATELLITE). Grigor'eva, G. M.; Gumennyi, V. A.; Kreinin, L. B.; Landsman, A. P. Kosm. Issled., 4: 740-7(Sept.-Oct, 1966). (In Russian).

"Electron-3" had an apogee of 7040 km and a perigee of 405 km. The inclination angle of its orbital plane to the equatorial plane was 60° 52'. As it orbited the Earth, the satellite intersected regions of intensive corpuscular radiation in the inner and outer radiation belts. Eight DSE experimental photoelectric detectors were installed on "Electron-3." Each detector consisted of a group of several photocells connected in series. The cells were made from p-type silicon into which phosphorus had been diffused. Both coated and uncoated detectors were used. The rapid deterioration of unprotected photocells was due principally to the effect of intensive low-energy proton fluxes (0.1 to 0.5 MeV). The presence of very thin coatings considerably reduced the rate of deterioration. Intensive low-energy proton fluxes (0.2 to 0.3 MeV) with a path length of the order of the depth of the n–p transition caused a sharp decrease in the open-current potential of unprotected photocells. Photocell damage produced by electrons on the "Electron-3" was slight. Measurements carried out over three months showed no drop in current in photocells protected with 3-mm-thick glass. Calculations showed that solar cells with 3-mm coatings could operate at least four years with a current reduction no greater than 25%. The investigation proved the feasibility of predicting how solar cells subjected to intensive cosmic radiations will react. (ATD)

LIFE SCIENCES

Biochemistry, Physiology, and Molecular Biology

Refer also to abstracts 8475, 8753, 8806, 8809, 8911, 9006, 9009, 9033, and 9046

8667 (AD-631206) A STUDY OF FLUORESCENT PRODUCTS IN THE URINE OF RATS EXPOSED TO IONIZING RADIATION. Progress Report, November 1964–October 1965. Demetriou, James A.; Maciasr, Frank M. (Northrop Space Labs., Hawthorne, Calif.). Feb. 1966. Contract AF41(609)-2679. 20p. (SAM-TR-66-13). CFSTI $1.00 cy, $0.50 mn.

The excretion of fluorescent products in the urines of nonirradiated rats and rats exposed to a lethal dose of ionizing radiation was investigated. Fractionation of the urine extracts by gel filtration chromatography yielded eleven fluorescent fractions. Several fractions in the urines of the irradiated animals showed marked decreases in total fluorescence. A new fluorescent fraction was found exclusively in the post-irradiation urines. In addition, other differences between the irradiated and nonirradiated animals were found by means of thin-layer chromatography. (TAB)

8668 (AD-634405) EFFECTS OF RADIATION ON THE SUBMICROSCOPIC STRUCTURE OF THE SYMPATHETIC NEURON. Final Report, March 16, 1962–July 15, 1964. Roppel, Richard M.; Melton, Carl W.; Peters, Arthur C.; Allton, Wayne H.; Prince, John E. (Battelle Memorial Inst., Columbus, Ohio). Apr. 1966. Contract AF 41(609)-1585. 17p. (SAM-TR-66-32). CFSTI $1.00 cy, $0.50 mn.

Hamsters were irradiated with supralethal, single doses, and with sublethal, fractionated doses of ^{60}Co gamma radiation. Autonomic ganglia were dissected from these animals at various times after irradiation and were studied by electron microscopy for evidence of morphologic change resulting from irradiation. When fixation was accomplished by direct immersion of tissues in permanganate solution, only minimal cellular changes that could be attributed to radiation were observed in sympathetic tissues following single massive doses of 10,000 to 100,000 R. When perfusion fixation was attempted, however, extensive fixation artifact was observed in the tissues of irradiated animals but not in controls. Fractionated-dose irradiation to a total of 500 R administered as ten 50 R doses resulted in an increase in the number of densely staining, cytoplasmic inclusion bodies observed in sympathetic neurons. A permanganate-sodium plumbate staining procedure which results in an electron microscope image of high contrast is described. (STAR)

8669 (CONF-660507-34) BIOLOGICAL ASPECTS IN THE DISPOSAL OF FISSION PRODUCTS IN SURFACE WATERS. Report No. 6 (Final). Beninson, D.; Vander Elst, E.; Cancio, D. (Comision Nacional de Energia Atomica, Buenos Aires (Argentina)). [1965]. IAEA Contract 183/RB. 28p. Dep. mn.

From Symposium for the Disposal of Radioactive Wastes into Sea, Oceans, and Surface Waters, Vienna.

Research on uptake of fission products by fresh water biota carried out by the Argentine Atomic Energy Commission is summarized. The work includes both laboratory measurements and determinations in field conditions, and relates to Sr, Cs, Zr, Ru, rare earths, and radioiodine. In relation to Sr transfer in aquatic food chains, Sr to Ca discrimination factors proved to be more significant for risk estimations than the usual concentration factors. It was found that vascular plants slightly prefer strontium over calcium (discrimination factor ranging from 1.0 to 2.5). Mollusks and fresh water fish, on the other hand, discriminated against Sr, with factors ranging from 0.35 to 0.75 according to species. The discrimination factors held over a wide range of Ca and other cation concentrations in water. Cesium to potassium ratios were found to be extremely dependent on the K concentration, and the discrimination concept was of little use. Cesium uptake was therefore characterized by quantitative concentration factors. Aquatic vascular plants concentrated substantial amounts of Cs, Ru, Zr, and rare earth radionuclides, concentration factors ranging from 2×10^2 to 3×10^4 according to the species and the nuclide. Particularly important concentrations were found for Ce. Mollusks and fish had much lower concentration factors for these nuclides (from 10 to a few hundreds). Radioiodine concentrations were low in all species examined. Substantial fractions of the disposed activities were removed from the water by exchange with the bottom materials and by sedimentation of suspended particles carrying radioactivity. Results in natural ponds with low water renewal rates show removal of about 90% of cesium, 40% of ruthenium, 60% of zirconium, and 90% cerium radionuclides. The values cannot be readily extrapolated to other field conditions, but oversight of the removal process in a given situation may lead to gross overestimation of risk. Some of the species tested, proved to be reasonably good indicators, useful for a rational operational monitoring scheme of an environment affected by a waste disposal practice. It was possible to identify present level indicators that follow readily the changes in the environment and integrating monitors with levels relating to the history of the environmental contamination. (auth)

8670 (COO-78-142) ANNUAL REPORT [ON RADIATION BIOLOGY], JULY 1, 1965–JUNE 30, 1966. Friedell, Hymer L. (Western Reserve Univ., Cleveland, Ohio. School of Medicine). Aug. 1, 1966. Contract W-31-109-eng-78. 153p. Dep. mn. CFSTI $5.00 cy, $1.00 mn.

Separate abstracts were prepared on four sections of this report. A list is included of seventeen publications during the period covered. (C.H.)

For abstracts of individual sections see: 8671, 8791, 8844, and 8910.

8671 (COO-78-142, pp 82-119) RADIATION BIOCHEMISTRY SECTION. (Western Reserve Univ., Cleveland, Ohio. School of Medicine).

X irradiation of DNA in dilute solution with 1000 R at a rate of 55 R/min was found to decrease the transforming activity and the incorporation of DNA by recipient cells in B. subtilis systems to a similar extent. Progress is reported on studies on the effects of ^{60}Co γ radiation on nuclear division of the slime mold, Physarum polycephalum. Cytoplasmic DNA, synthesized during G_2-interphase, was demonstrated in Physarum with the aid of triated thymidine and ^{32}P used as tracers and density gradient centrifugation techniques. Chromatographic and electrophoretic techniques were used to separate proteins in a study of protein metabolism in cultered Chinese hamster ovary cells in which the incorporation of ^{3}H-thymidine was used as an index of DNA synthesis. (C.H.)

8672 (MIT-952-3, pp 202-317) METABOLISM OF INTRAVENOUSLY ADMINISTERED RADIUM AND THORIUM IN HUMAN BEINGS AND THE RELATIVE ABSORPTION FROM THE HUMAN GASTROINTESTINAL TRACT OF RADIUM AND THORIUM IN SIMULATED RADIUM DIAL PAINTS. (Massachusetts Inst. of Tech., Cambridge. Dept. of Physics).

An experiment has been conducted to determine the relative absorption of thorium to radium from the gastrointestinal tract of normal human beings. This information is necessary in the interpretation of the toxicity data of Ra dial painters, a large number of whom ingested not only ^{226}Ra but also ^{228}Ra along with some fraction of an equilibrium amount of its daughter, ^{228}Th. For use in toxicity correlations to date, the dosimetric equivalent of ^{228}Ra has been expressed as a minimum pure ^{226}Ra equivalent (MPRE) which presumes no dosimetric contribution from originally ingested ^{228}Th. Each of a group of elderly male and female human subjects was administered, intravenously, carrier-free ^{224}Ra in saline or ^{234}Th in isotonic citrate. Metabolic studies, conducted over a period of 21 days for Ra and 4 months for Th, include measurements on blood, urine, feces, and breath samples, and on the whole body and the upper 20% of the body with the gastrointestinal tract shielded, using a new so-called "skull and crossbones" (SXB) position. The whole body retention of Ra decreases to ~15% in 20 days, while Ra in the total blood volume decreases to 0.3% in 4 days. The amount of Th in the breath drops quickly in 2 days and decreases to 1.5% of the total Th in 20 days. Radium is excreted predominantly by the fecal route, the feces-to-urine ratio averaging ~30. The crossover time (the time when the blood and skeletal specific activities are equal) is estimated to be ~75 days (range 40 to 150). The whole body retention of Th is ~90% at 2 months, and decreases slowly, while Th in total blood decreases to ~0.3% in 10 days. Th is excreted mainly through the urinary route, the urine-to-feces ratio averaging ~10 for males and ~20 for females. The shielded SXB measurements indicate a disproportionately smaller amount of Th in the upper ~20% of the body for males than for females. The reasons for these two sex differences in the metabolism of Th are unknown. Each of a second group of elderly male and female normal human subjects was administered, orally, a gelatin capsule containing simulated Ra dial paint consisting of ^{224}Ra SO_4, ^{234}Th $(SO_4)_2$, and $BaSO_4$ carrier deposited on ZnS phosphor to simulate the original Ra dial paints. The transport of Ra and Th across the gut wall was determined by the same measurements described

above which provided calibration data for this phase of the experiment. The results indicate a transport of 15–20% of the Ra across the gut wall. This value is unexpectedly high, comparable with that of Ra from drinking water. The detection of the transport of Th is borderline, corresponding to ~0.1% that of Ra within a factor of 2. It is concluded that the absorption of ^{228}Th from real dial paints is unlikely to have been high when dial painters tipped their brushes in the 1920's. Therefore, in these dial painters the contribution to the integrated radiation dose by the initially absorbed ^{228}Th is ≤5% that due to ^{228}Ra. (auth)

8673 (ORNL–3978) THE MOLECULAR ANATOMY OF CELLS AND TISSUES (THE MAN PROGRAM). Annual Report, July 1, 1965–June 30, 1966. (Oak Ridge National Lab., Tenn.). Nov. 1966. Contract W-7405-eng-26. 99p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The Molecular Anatomy (MAN) Program is concerned with the development of tools for the dissection and analysis, down to the molecular level, of cells and tissues. The following questions are asked: If available separation methods are extended to the limits of experimental resolution, would they resolve the complex mixture that is the cell? Given a complete molecular scan of cell contents in health and in disease, would differences due to an underlying malfunction be evident? What specific systems remain to be developed before a reasonably complete description of the molecular anatomy of a cell may be written? This report analyzes some aspects of these questions, describes analytical systems being developed under the program, and presents results of various bioseparations. Two new zonal centrifuge rotors, B-XIV and B-XV, are described in detail, together with studies on the application of these rotors to particle isolation. Both rotors allow large-volume rate-zonal and isopycnic-zonal centrifugation to be done in conventional preparative ultracentrifuges. In addition, a computer method has been developed for calculating the radial distance from the center of the rotor for a specific volume, and improvements have been made to other B Series rotors. A series of rotors is being designed and tested for large-scale virus isolation and other purposes by use of the continuous-flow principle. The prototype K-I rotor operates in the conventional air-driven Sharples machine. The large-volume (<10 liters/hr) K-II rotor is the first of several rotors that are being designed to do specific tasks. Direct motor drive or an air turbine will probably be the most economical method of spinning a production model of the K-II rotor. Advanced concepts, such as high-speed drive systems and magnetically suspended rotors, are being explored. Materials requirements are stringent for systems in these categories because of extremely high g forces. From experimental separations with several rotors, results with a number of materials are reported: lysosomes, human breast tumors, and natural waters. High-performance chromatographic systems are being modified and refined. A laboratory model of an automated carbohydrate analyzer is described, together with results of experiments in following changes in soluble carbohydrates of synchronized Tetrahymena and in assaying sugars of human urine. Ultraviolet-absorbing components of urine were chromatographically separated with a modified nucleotide analyzer. From a group of supporting studies, the following is reported: (1) physical properties of potassium citrate solutions, (2) design and testing of dialysis equipment and density indicator beads, (3) stress and corrosion tests in sodium perchlorate, and (4) determination of carbon in liquid streams or solid samples with a flame-ionization analyzer. This program is cosponsored by the National Cancer Institute and the U. S. Atomic Energy Commission. (auth)

8674 (ORNL–3999, pp 159) MICROBIOLOGY. (Oak Ridge National Lab., Tenn.).

Progress is reported on electron transport mechanisms in microorganisms. Characteristic properties which differentiate malic-lactic transhydrogenase from other pyridine-nucleotide dehydrogenases are being investigated. (H.L.W.)

8675 (ORNL–3999, pp 134-9) NUCLEIC ACID ENZYMOLOGY. (Oak Ridge National Lab., Tenn.).

Progress is reported on the following studies: immunologic properties of T_2-specific proteins; repair mechanism of T5 bacteriophage DNA molecules; mechanism of inhibition of nucleic acid syntheses by colicine E2; partition of transfer ribonucleic acid between aqueous salt solutions and trichlorotrifluoroethane containing a quaternary amine; further purification of the oligodeoxyribonucleotide transferase enzymes; sRNA's and protein synthesis; multiple aminoacyl-RNA synthetase systems; P^1, P^4 diguanosine 5′-tetraphosphate and brine shrimp embryogenesis; uracil-containing compounds in amphibian eggs; lifetime of ribosomal RNA in a nongrowing tissue; breakdown and re-formation of somatic muscle during the molt cycle of the land crab, Gecarcinus lateralis. (H.L.W.)

8676 (ORNL–3999, pp 143-52) ENZYMOLOGY. (Oak Ridge National Lab., Tenn.).

Progress is reported on the following studies: isolation of mitochondrial sRNA; purification and characterization of tRNA pyrophosphorylase; configuration studies of Escherichia coli polysomes; studies on polysomes in rat spleen during the immune response; studies on polysomes in spleens of rats treated with actinomycin D; studies on the enzyme recognition site in phenylalanine tRNA; large-scale isolation of phenylalanyl-RNA synthetase from Escherichia coli B; effect of methylation of phenylalanine transfer RNA from Escherichia coli; isozymes: their regulation and genetic control; phylogenetic comparison of lactate dehydrogenase isoenzymes in rodents; inhibition of valyl-tRNA synthetase by polyribonucleotides; a test of tRNA as amino acid adaptor in hemoglobin synthesis. (H.L.W.)

8677 (ORNL–3999, pp 153-8) BIOCHEMICAL REGULATION. (Oak Ridge National Lab., Tenn.).

Progress is reported on the following studies: metabolic turnover of rat liver tyrosine transaminase: effects of inhibitors of RNA and protein synthesis; hormonal control of enzyme levels in the Reuber hepatoma in vitro; repression of enzyme synthesis by growth hormone; RNA synthesis in fetal rat liver; induction of tyrosine-α-ketoglutarate transaminase in fetal rat liver by hydrocortisone; stimulation of tRNA synthesis by hydrocortisone; studies on the mechanism of insulin and glucagon induction of tyrosine-α-ketoglutarate transaminase from rat liver. (H.L.W.)

8678 (ORNL–3999, pp 166-75) BIOPHYSICS. (Oak Ridge National Lab., Tenn.).

Progress is reported on the following studies: studies of plastid ribosome RNA; enzymic synthesis of polydeoxynucleotides on dA : dT templates; effect of some chromosome-breaking agents on the DNA polymerase and nuclease activity of Chinese hamster cells; the continuity of Escherichia coli DNA; photoreactivating enzyme in animals; strand breaks that result from the excision of pyrimidine dimers from DNA; loss of pyrimidine dimers from bacterial DNA as a result of phage infection; excision of dimers in vitro; effect of UV irradiation on spore DNA; short wavelength reversal of uracil dimers in Poly U at 77°K; electron spin resonance observations of the triplet state in tyrosine and Poly-L- Tyrosine; moisture dependence of endogenous ESR signals in seeds; recalibration of chronic ^{60}Co gamma-ray facility. (H.L.W.)

8679 (ORNL–3999, pp 176-206) COOPERATIVE PROGRAMS. (Oak Ridge National Lab., Tenn.).

Progress is reported on the following studies sponsored by the AEC-NIH Chemical Carcinogenesis program: studies of the mechanism of action of oncogenic viruses; development of tissue culture lines for studies on chemical carcinogenesis; ethionine carcinogenesis; leucyl-tRNA: chromatographic properties from normal and T_2-infected E. coli B; further studies on the amino acid incorporating system from trout liver; diethylnitrosamine-induced tumors in RF mice; estimation of water consumption by individual mice caged in groups; aminoacyl-tRNA ligases from normal and neoplastic human cells; N-methyl-N′-nitro-N-nitrosoguanidine as a mutagen for Paramecium; the effect of 3,4-benzpyrene on cell size and growth rate in Paramecium; a FORTRAN program for application of the multiple isomorphous replacement method to protein crystal structures; fluorescence of polytryptophans at room temperature; fluorescence energy transfer in poly-L-tyrosine and related model compounds; N-methyl-N′-nitro-N-nitrosoguanidine as a mutagenic agent for Neurospora crassa; mutagenicity of methylhydroxylamines in Neurospora crassa; inhalation carcinogenesis; lymphatic tissue germinal center localization of ^{125}I-labeled heterologous and isologous macroglobulins; prolonged antibody synthesis of spleen cells cultured in diffusion chambers; chromosomal aberrations in cells following infection with virus; aminoacyl-tRNA ligase systems of viral infected cells; photodynamic action of benzo(A)pyrene and 355 mμ illumination of Escherichia coli; metabolic studies on 1(4-dimethylaminobenzylidene)-indene. Progress is reported on the following studies sponsored by the AEC-NIH Molecular Anatomy Program: studies on native glycogen isolated by combined rate-zonal and isopycnic zonal centrifugation; cellular sites of synthesis in Euglena gracilis; ultracentrifugation study of tumor antigens. Progress is reported on the following studies sponsored by the AEC-NASA Space Biology Program: survival of Neurospora conidia in simulated three-day biosatellite hardware; biocompatibility tests of flight hardware for the Neurospora three-day biosatellite experiment; a simulated space-flight test for Habrobracon; biocompatibility tests of Habrobracon under space-flight conditions in the flight vehicle. (H.L.W.)

8680 PYRIMIDINE DIMERS IN ULTRAVIOLET-IRRADIATED DNA'S. Setlow, R. B.; Carrier, W. L. (Oak Ridge National Lab., Tenn.). J. Mol. Biol., 17: 237-54(May 1966). (ORNL-P-1652).

An examination was made of the photoproducts in DNA's labeled specifically with radioactive cytosine (C) or thymine (T). The

dimers CT and CC were identified by photochemical techniques, and TT, UT, and UU (U = uracil) by photochemical and chromatographic techniques. All the pyrimidine dimers have similar, but not identical, photochemical properties, and they are all monomerized by preparations of photoreactivating enzyme plus visible light. The dimers TT, CT, and CC were identified as primary photochemical products, and UT and UU as secondary products that result from the deamination of cytosine-containing dimers. The relative efficiency of forming dimers per dinucleotide is in the order TT > CT > CC, and the relative cross-sections for splitting them by short wavelengths are CC ≅ CT > TT = UT = UU. All the pyrimidine dimers interfere with nuclease action and inhibit DNA synthesis in vitro. The number of cytosine-containing dimers is comparable to TT. For example, in Escherichia coli DNA irradiated with low doses, only 60% of the dimers are TT, and in Micrococcus lysodeikticus DNA only 20% are TT. At high doses the proportion of TT is greater than at low doses. The amounts of uracil that are observed as a result of irradiation of ^{3}H-cytosine-labeled DNA are much less than the amounts of cytosine-containing dimers. The new dimers described here do not involve a major re-evaluation of previous concepts about photoproducts in DNA, but only the substitution of the phrase "pyrimidine dimers" for "thymine dimers" used in most earlier investigations of the effects of uv radiation on DNA, and a re-evaluation of the numbers of dimers formed at a given dose. (BBB)

8681 PLASMA MINERALS IN NORMAL AND NEUTRON IRRADIATED BURROS. Haley, Thomas J.; Cartwright, Frank D.; Brown, Daniel G. (Univ. of California, Los Angeles. UT-AEC Agricultural Research Lab., Oak Ridge, Tenn.). Nature, 212: 820-1(Nov. 19, 1966).

Burros were exposed to fast neutron irradiation of the whole body or the torso only. Dried plasma was analyzed for calcium, chloride, copper, iron, magnesium, phosphorus, potassium, sodium, sulfur, and zinc. In animals with torsos only irradiated, significant changes in plasma concentrations of phosphorus, iron and copper occurred. Whole-body irradiation resulted in a significant elevation of the plasma concentration of magnesium, phosphorus, iron and copper. All animals exposed to whole-body doses above 200 rads died within 16 to 49 hrs. (H.L.W.)

8682 SELENIUM METABOLISM. I. RESPIRATORY EXCRETION. Hirooka, Tsutomu; Galambos, John T. (Emory Univ., Atlanta). Biochim. Biophys. Acta, 130: 313-20(Dec. 28, 1966).

The amount of injected selenite or selenate had a significant effect on its metabolism. This effect rapidly decreased with time and was no longer detectable 48 hr later. The observations are compatible with the hypothesis that the reduction of selenite and selenate and the methylation of Se take place in the liver. Methylation of Se and the respiratory excretion of dimethyl selenide were not impaired in rats with choline-deficient diet-induced fatty liver and cirrhosis. Rats fed a choline-deficient diet for 10 months reacted as if they also became Se-deficient. Experimental liver injury had a significant effect on the metabolism of selenate in vitro. (auth)

8683 SELENIUM METABOLISM. III. SERUM PROTEINS, LIPOPROTEINS, AND LIVER INJURY. Hirooka, Tsutomu; Galambos, John T. (Emory Univ., Atlanta. Grady Memorial Hospital, Atlanta). Biochim. Biophys. Acta, 130: 321-8(Dec. 28, 1966).

The amount of carrier SeO_4^{2-} had a significant effect on the distribution of ^{75}Se, after $^{75}SeO_4^{2-}$ injection, in the serum lipoproteins and serum proteins. This effect could not be due to simple dilution of ^{75}Se by the carrier Se. After the administration of $^{75}SeO_4^{2-}$, the lipid fraction of serum lipoproteins was firmly labeled with ^{75}Se both in the rat and in man. There was a higher association of ^{75}Se with α_2 globulins than with other serum protein fractions both in the rat and in man. In patients with liver disease, which was associated with alcoholism, there was an increased binding of ^{75}Se by serum lipoproteins after the injection of $^{75}SeO_4^{2-}$ of high specific activity. In a patient with cirrhosis hepatoma the ^{75}Se concentration was the highest in the kidney and the largest amount was in the liver 8 days after injection. No significant ^{75}Se uptake was found in the hepatoma. (auth)

8684 A REVIEW: APPLICATIONS OF THE LASER BEAM IN CANCER BIOLOGY. Goldman, Leon (Children's Hospital Research Foundation, Cincinnati). Int. J. Cancer, 1: 309-18(July 15, 1966).

This survey considers latest developments in laser instrumentation, protective measures against personnel exposure, effects of laser beams on tissues, biological and medical applications of lasers, and their use in tumor research and treatment. Laser research has shown that experimental melanomas in animals or human melanomas, in areas accessible to the laser with impact on an adequate target area and energy densities of at least 1000 to 2000 J/cm^2, can be destroyed completely. Experiments with cancer may spread after laser impact, especially when inadequate energy densities and inadequate target areas are used. The most significant studies in respect to cancer in man have been done with the melanomas, because their dark color serves as an excellent laser-absorbing medium. In pigmented tissues a marked increase in melanin production occurs after laser irradiation. This has been shown also in laser surgery of the eye. Laser-treated superficial melanomas of the skin heal with an acceptable smooth scar. Biopsy studies of such adequately treated areas show nonspecific fibrosis and absence of melanoma. (BBB)

8685 RE-EVALUATION OF THE EFFECT OF ESTROGEN ON THYROID ACTIVITY IN THE RAT AND ITS MECHANISM. Yamada, Takashi; Takemura, Yoshihiro; Kobayashi, Isao; Shichijo, Kojiro (Gunma Univ., Maebashi, Japan). Endocrinology, 79: 849-57(Nov. 1966).

Estradiol benzoate (EB) was injected subcutaneously daily for 14 days into male and female rats. Over a wide dose range, EB produced an increase of thyroid weight and thyroidal radioiodine uptake. The increase in these indices was roughly proportional to the doses of EB used. By similar treatment, thyroidal radioiodine release was increased. In hypophysectomized animals, EB stimulated thyroidal radioiodine uptake slightly, but had no effect on thyroid weight. The EB-induced increase of thyroid weight and thyroidal radioiodine uptake of intact animals decreased progressively with the administration of increasing doses of thyroxine, but, at all levels of thyroxine dosage, thyroid weight and thyroidal radioiodine uptake were greater in EB-treated animals than in the controls. A statistically significant increase in the uptake of labeled thyroxine from plasma by human red blood cells and rat diaphragm was caused by EB. Plasma PBI in thyroidectomized, thyroxine-maintained animals was lowered by EB. It is concluded that EB augments thyroid activity by directly stimulating the thyroid at all levels of circulating TSH, and by augmenting TSH release via the feedback mechanism. (auth)

8686 EFFECT OF α-PARTICLE MICROBEAM IRRADIATION ON THE SYNTHESIS OF DEOXYRIBONUCLEIC ACID IN TISSUE CULTURE. Kuzin, A. M.; Wainson, A. A. (Inst. of Biophysics, Moscow). Nature, 212: 819-20(Nov. 19, 1966).

The dependence of the rate of DNA synthesis on the dose of irradiation given to a nucleus or to cytoplasm was investigated. After irradiation, the incorporation of tritiated thymidine was measured autoradiographically. HeLa cells were grown on mica films. Polonium was used as a source for α particle microbeam irradiation. A comparison was made of the rates of DNA synthesis in irradiated and control cells growing on the same mica film. Irradiation of cytoplasm resulted in a significant inhibition of DNA synthesis 1 hr after irradiation, but the absorbed dose needed to be ten times larger than that which gave similar results with nuclei. (H.L.W.)

8687 INCORPORATION OF COBALT INTO NUCLEIC ACIDS OF THE CHICK EMBRYO. Menke, K. H.; Sarif-Sarban, M. (Univ., Bonn). Nature, 212: 821-2(Nov. 19, 1966).

Five μg of ^{60}Co was injected into 11-day old chick embryos. After incubation for 44 hrs the nucleic acids were prepared and the radioactivity was measured. The results show an uptake of 2.4 to 11%. The first precipitation of nucleic acid contains mainly cobalt bound to proteins. The specific cobalt content in the second precipitate increases with the dose of injection from 1 to 40 m μg cobalt/g of nucleic acid. Injections of 20, 50 or 100 μg of cobalt per egg do not increase the cobalt content of 8 and 4 m μg/g although the uptake of the total embryo increases further from 0.7 to 2.4 μg cobalt per egg. The saturation points of 8 and 4 m μg cobalt/g correspond to an average distribution of one cobalt atom in 23×10^6 and 46×10^6 nucleotides, respectively. (H.L.W.)

8688 STUDIES ON HORMONE SYNTHESIS IN PRIMARY HYPOTHYROIDISM. Maruyama, Tomomichi; Sato, Takuya (Shinshu Univ., Japan). Shinshu Igaku Zasshi, 14: 437-43(Nov. 1965). (In Japanese).

Two cases of primary hypothyroidism accompanied by iodide disorganization and deiodination of iodotyrosine have been studied. One was a 21 year old male who had a large goiter and showed a low PBI level, a relatively high iodine-131 uptake and a low tritium-erythrocyte uptake. This patient did not respond to injection of 5 USP thyrotropin (Thytropar, Armour). The potassium perchlorate discharge test gave a positive result. Deiodination of iodotyrosine was abnormally inhibited. The other case was a 6 year old boy. His laboratory findings were similar to those of the previous case. In addition, in this case, in vivo organization of iodide was analyzed by iodine-131 paper chromatography. The results were as follows: I, 72.6%; MIT, 19.9%; DIT, 7.5%. From these results, it appeared that there was an impaired dehalogenase activity and a coupling defect of iodotyrosine. (H.L.W.)

8689 ACUTE EFFECTS OF THYROTROPIN ON THYROID HORMONE BIOSYNTHESIS IN THE RAT. Shimoda, Shin-ichi; Kendall, John W.; Greer, Monte A. (Univ. of Oregon, Portland). Endocrinology, 79: 921-6(Nov. 1966).

Incorporation of radioiodine into intrathyroidal iodoamino acids was studied in Purina-fed rats at intervals ranging from 15 min to 12 hr after TSH administration. As has previously been reported, there is a latent period of several hours before TSH stimulates thyroidal radioiodine uptake. An initial decrease in 3-hr thyroidal ^{131}I uptake was found when TSH was injected 2 hr before radioiodine. Progressive increases in uptake were seen when TSH was given 4, 8, and 24 hr before radioiodine, but these were significantly different from non-TSH treated controls only at 8 and 24 hr. In contrast to the lack of an early effect on ^{131}I uptake, TSH administered immediately before ^{131}I strikingly altered the composition of radioiodinated substances within the thyroid gland within 30 min. There was a marked stimulation of thyronine synthesis and a corresponding decrease in diodothyronine synthesis. A lesser increase in T and a questionable reduction in monoiodothyronine formation were also found. Stimulation of labeled iodothyronine synthesis within 30 min after TSH administration was also seen in hypophysectomized animals. It is suggested that TSH rapidly stimulates the coupling of freshly iodinated iodotyrosines to form iodothyronines. (auth)

8690 THE SIGNIFICANCE OF DEOXYRIBONUCLEASE II FOR THE EFFECT OF SINALOST, TRIETHYLENE MELAMINE, AND X RAYS FOR THE NUCLEIC METABOLISM OF THE RAT. Tempel, K.; Roessner, W. (Univ., Munich). Arch. Exp. Pathol. Pharmakol., 253: 89-90(1966). (In German).

Among the earliest reactions to whole-body x irradiation, or treatment with Sinalost or triethylaminemelamine, observed in spleen, thymus, and serum of rats was an increase in trichloroacetic acid-soluble compounds that contain deoxyribose. The maximum concentrations were reached within 2 to 6 hr following treatment. These decreased later, but the in vitro specific activity of deoxyribonuclease II increased within $3\frac{1}{2}$ hr in spleen after whole-body irradiation and after 8 to 16 hr in thymus. The maximum activity was reached 16 to 24 hr after whole-body irradiation. At the same time a second increase in deoxyribose compounds was observed. The concentration of these compounds also increased in urine in proportion to the dose of whole-body irradiation received. These effects may be due to a combination of a nonenzymatic tissue injury mechanism and an enzymatic mechanism that coincides histochemically and chronologically with a phagocytic phase. Thus the increase in deoxyribose compounds may represent inhibition of DNA synthesis and its destruction, resulting in the appearance of both precursor and breakdown product of DNA. (BBB)

8691 ESR STUDY OF NUCLEOSIDES AND NUCLEOTIDES BOMBARDED WITH HYDROGEN ATOMS. Herak, Janko N.; Gordy, Walter (Duke Univ., Durham, N. C.). Proc. Nat. Acad. Sci. U. S., 56: 7-11(July 1966).

Nucleosides and nucleotides were bombarded with H atoms at room temperature, at 195°K (dry-ice temp.), and at 77°K; they were observed at either room temp. or at 77°K. Specimens were cooled with liquid nitrogen or dry ice and acetone while being bombarded and were then shaken into a sample tube immersed in liquid nitrogen. All observations were made at a frequency of 9 Gc. Hydrogen-addition radicals were demonstrated in previous work on bombardment of powdered RNA; in contrast, no such radicals were found in bombarded DNA samples. In this paper, it was found that H-addition radicals are formed in all nucleosides and nucleotides except, possibly, those derived from adenine. These results indicate that failure to form such radicals in DNA is not due to the presence in DNA of a different sugar group from that in RNA. It is concluded instead that the molecular arrangement of DNA is such that H atoms cannot reach the site for addition. The same shielding must occur for the nucleosides and nucleotides of adenine, but not for those of the other bases. This indicates that H addition on the purine ring in RNA occurs on the guanine constituent. At present, it is not known whether the H-addition radicals of the pyrimidines in RNA occur at the uracil or at the cytosine ring. It is recognized that the shielding against H-atom attack evidenced in these experiments using pure dry DNA may not be valid under conditions prevailing in the biological cell. (W.E.B.)

8692 CHANGE IN THE NUCLEOTIDE COMPOSITION OF THE DNA OF COTTON SEEDS UNDER THE ACTION OF ^{60}Co γ RAYS. Khalikov, D. R.; Ibragimov, A. P.; Turakulov, Ya. Kh. Dokl. Akad. Nauk Uz. SSR, 22: No. 5, 46-8(1965). (In Russian).

Changes induced in the nucleotide composition of the DNA of Gossypium hirsutum by ^{60}Co γ rays were studied in three varieties different in respect to time of ripening (early ripening, average, or late ripening). In the early ripening variety the composition of DNA bases was not substantially changed in 15-day shoots after a 1 kR dose, a dose that resulted in a shift of the adenine/thymine ratio of the late-ripening variety from 1.02 to 1.9. In seeds of all varieties seeded 14 days after irradiation with 6 kR, there were significant changes in the DNA composition. It is concluded that the change in thymine is not the result of the direct action of radiation, being attributed to the fact that early-ripening varieties were more radioresistant. (H.G.D.)

8693 PENETRATION OF ^{131}I THROUGH THE INTACT HUMAN SKIN. Zarkovic, G.; Fajgelj, A.; Popovic, N. (Medical Coll., Sarajevo, Yugoslavia). Arhiv Hig. Rada Toksikol., 16: 319-27(1965). (In Croatian).

Results are reported from an investigation on the percutaneous penetration of ^{131}I in 17 men and 12 women during 48 hours following the application of 80 to 100 μc of $Na^{131}I$ under a plastic occlusive dressing. Sodium perchlorate, 100 mg, was fed daily to prevent thyroid uptake of the isotope. Absorption was found higher in women, and higher on the dorsal than palmar surface of the hand. (JPRS)

8694 HISTOCHEMICAL STUDY ON ALKALINE AND ACID PHOSPHATASE OF UTERINE CERVIX CANCER, ESPECIALLY IN THE TELECOBALT THERAPY. Ito, Takashi (Univ. of Nagoya, Japan). Nippon Sanfujinka Zasshi, 17: 982-90(Sept. 1965). (In Japanese).

A study was made of the activity of alkaline and acid phosphatases in the female genital organs of a total of 61 patients with cancer of the uterine cervix and patients without cancer. The effects of ^{60}Co teletherapy on phosphatase activities of tissues exposed to 2000 to 4000 R γ radiation were also studied, and it was found that irradiation caused a slight increase in the activity of alkaline phosphatase in cancer cells and that the effect on the activity of acid phosphatase was variable. A comparison of the histology and activity of both enzymes in slide smear preparations from patients without cancer, patients with active cancer, and patients with operated and irradiated cancer showed that the reactions of both enzymes in cancer cells were irregular and diverse, indicating disturbed metabolism in the cancer cells. It is suggested that phosphatase activity may be used as an auxiliary means of differential diagnosis of cancers of the uterine cervix. (C.H.)

8695 CLINICAL AND EXPERIMENTAL STUDIES ON ^{32}P-ABSORPTION THROUGH DIGESTIVE CANALS. PART 1. CLINICAL OBSERVATIONS. Sugawara, Yasuo (Hirosaki Univ., Japan). Nippon Shokakibyo Gakkai Zasshi, 62: 139-52(Feb. 1965). (In Japanese).

Phosphorus-32 was administered per os to 129 patients having neither heart nor kidney diseases nor edema and to 10 normal persons, and the absorption through the intestinal walls was studied by measurements of its blood concentration and excretion into the urine and stools. Phosphorus-32 appeared in the blood about 5 min after the oral administration, and the blood concentration gradually increased, reached a maximum after 3 hours, then gradually decreased. A positive correlation was seen between the blood concentration of ^{32}P and excretion into the urine. The absorption of ^{32}P tended to decrease with the age of the patient. The blood concentration of ^{32}P was lower in liver diseases and after operation on digestive system, and it was high in ulcerative colitis and endocrine disorders. Absorption tended to increase with the acidity of gastric juice. Absorption was lower in patients with insufficient liver function than in the normal group. No correlation was seen between ^{32}P absorption through the digestive tract and fat and protein absorption. The administration of multivalent pancreatic digestive enzyme accelerated the absorption of ^{32}P. The absorption of ^{32}P tended to increase when ^{32}P was administered after a meal, compared with its administration during fasting. No correlation was seen between the blood properties and the values of many different serum tests and ^{32}P absorption. (auth)

8696 EFFECT OF TOTAL DOSE, DOSE RATE, AND TIME OF IRRADIATION ON SYNTHESIS OF DEOXYRIBONUCLEIC ACID. Chang, L. O.; Williams, S. S.; Looney, W. B. (Univ. of Virginia, Charlottesville). Nature, 211: 300-2(July 16, 1966).

The effects of x-irradiation on DNA synthesis were studied in 21 hr regenerating rat liver. Total radiation dose and dose rate appeared to be of secondary importance to the time period of irradiation in the depression of DNA synthesis over a dose range of 94 to 1500 rads and a dose-rate range of 1.6 to 300 rads/min. The most pronounced effects occurred during the first few minutes. Depression of DNA synthesis occurred at a dose (94 rads) equivalent to the D_{37} dose for survival of mammalian cells. It is concluded that the process of DNA synthesis is not radioresistant when total dose, dose rate, and duration of irradiation are taken into account. (H.G.D.)

8697 STUDIES ON NODULAR GOITER WITH RADIOACTIVE PHOSPHORUS (^{32}P). PART I. ^{32}P UPTAKE RATIO ON

NODULAR GOITER. Yamaguchi, Tomoyasu (Shinshu Univ., Korea). Shinshu Igaku Zasshi, 14: No. 1, 30-7(May 1965). (In Japanese).

The uptake of ^{32}P by tissues of thyroid cancer and simple nodular goiter was determined using a G-M counter. The ^{32}P uptake ratio was above 25% in 13 of 17 thyroid cancers, and below 24% in the remaining 4. The nodules which are cystic or small in size, or situated deep in the gland sometimes showed a ratio below 24%. In simple nodular goiter the ^{32}P uptake ratio was found to be below 24% in 27 out of 30. Data showed that the uptake ratio was higher in thyroid cancer than in simple nodular goiter. In simple nodular goiter, however, the ratio varied with the histological feature of the nodule. Less differentiated adenoma showed a relatively high value as compared with more differentiated adenoma. The tissue/serum ratio of ^{32}P of thyroid cancer was observed to be 6.28 average, which is remarkably higher than that of normal thyroid. The tissue/serum ratio of ^{32}P of simple nodular goiter was observed to be 2.35 in average, which is close to that of normal thyroid and considerably lower than that of thyroid cancer. Some relationships were recognized between the tissue/serum ratio of ^{32}P radioactivity and the histological feature of simple nodular goiter. The ratio is higher in less differentiated adenoma, and lower in more differentiated adenoma. Both the uptake ratio and the tissue/serum ratio of ^{32}P are remarkably higher in thyroid cancer than in simple nodular goiter. These results can be applied to the differential diagnosis between thyroid cancer and simple nodular goiter. (auth)

8698 STUDIES ON NODULAR GOITER WITH RADIOACTIVE PHOSPHORUS (^{32}P). PART III. TSH DEPENDENCY ON NODULAR GOITER. Yamaguchi, Tomoyasu (Shinshu Univ., Korea). Shinshu Igaku Zasshi, 14: No. 1, 51-63(May 1965). (In Japanese).

The effects of TSH upon ^{32}P uptake in thyroid cancer and simple nodular goiter were studied in vitro. The increased ratio of ^{32}P uptake after addition of TSH into the solution was evaluated in every fraction of phosphorus compound. In normal thyroid the ^{32}P uptake was increased by TSH and the increased ratio was highest in the phospholipid fraction. In thyroid cancer the ^{32}P uptake was increased by TSH in some degree but the increased ratio was extremely low as compared with normal thyroid. In anaplastic carcinoma, however, the increased ratio was lower than in papillary carcinoma. In simple nodular goiter, the increased ratio of the ^{32}P uptake after addition of TSH varied with the histological features of the nodule. In colloid adenoma the ratio was close to that of normal thyroid, and in tubular adenoma remarkably low as compared with normal thyroid. (auth)

8699 BINDING OF ^{131}I BY HEART PROTEINS IN THE RABBIT. Paulov, Stefan; Hladka, Marta (Univ., Komenskeho, Bratislava). Biologia, 20: 364-6(1965). (In Czech).

The distribution of ^{131}I, under in vitro conditions, among proteins of rabbit heart muscle was investigated. The freshly excised myocardial tissue was rinsed in 0.9% NaCl solution to remove blood and homogenized in pH 9.0 Veronal-acetate buffer (ionic strength 0.06). One g of cardiac tissue per 1.5 ml of buffer was used. The homogenate was centrifuged, and ^{131}I-iodide was added to the supernatant. Paper electrophoresis of this ^{131}I-containing protein extract was conducted at pH 9.3. Five protein fractions were separated, each containing ^{131}I in proportion to the concentration of the protein fraction. The middle protein fraction made up about 30% of the total protein and contained about 30% of the protein-bound ^{131}I. (BBB)

8700 EFFECT OF γ RAYS ON THE EFFECTIVENESS OF A FEW POLYRIBONUCLEOTIDES AS MESSENGERS. Ekert, Bernard; Grunberg-Manago, Marianne (Fondation Curie, Paris. Laboratoire de Biologie Physicochimique, Paris). Compt. Rend., Ser. D, 263: 1762-5(Nov. 28, 1966). (In French).

Experiments were conducted on the effects of γ radiation on polyribouridylic acid. When the irradiation occurred in the absence of oxygen the inactivation of polyphenylalanine was more pronounced. Experiments on the effects of γ radiation on polyriboadenylic acid showed that in the presence of oxygen polyriboadenylic acid was inactivated for the formation of polylysine. When the irradiation occurred in the absence of oxygen there was a pronounced stimulation of its coding activity. In conclusion, it appeared that the principal effect of ionizing on polyribonucleotides was rapid inactivation of the capacity to serve as messengers, a direct consequence of fragmentation of the chain. Furthermore, no change of specificity for the incorporation of amino acids could be observed in spite of partial modification of bases. (H.L.W.)

8701 BIOLOGIC ACTION OF RADIATIONS OF NUCLEIC ACIDS. Esposito, S.; Buscarini, L.; Cherie Ligniere, E. L.; Veltri, C.; Pozzi, E. (Univ., Pavia, Italy). Haematologica, 50: 575-610(1965). (In Italian).

This review, referring to 91 publications, considers the effects of uv and ionizing radiations on the synthesis and structure of RNA and DNA, and on the transcription of the genetic code in DNA. Alterations in nucleic acid molecules induced by uv or x irradiation are examined under the topics of depolymerization of the molecules, changes in the purine and pyrimidine bases, chromosomal breakage and other aberrations, and frequency of mutations. The interrelation between carcinogenesis and radioinduced changes in nucleic acids is also examined. The evidence indicates that injury to cell metabolism and replication can be attributed to radiation effects on nucleic acids. Enzyme impairment may result from disorders in transcription of the genetic code caused by irradiation; thus, this effect is manifested as a result of damage to RNA rather than to the enzyme per se. No conclusive evidence implicates carcinogenesis to radiation effects on nucleic acids but many indirect arguments favor the concept of cancer development from radioinduced mutations. (BBB)

8702 RADIOCHEMICAL DEGRADATION OF THREONINE AND SERINE. Pageau, R.; Mehran, A. R. (Laval Univ., Que.). Nature, 212: 98-9(Oct. 1, 1966).

Carbon-14-labeled serine and threonine were γ-irradiated with various doses from a ^{60}Co source. The percentages of degradation in aerated and oxygen-free solutions are shown by means of graphs. Threonine was more sensitive to radiation than serine. Oxygen did not affect degradation of either amino acid in 0.01 or 0.005 M solutions, but its influence was evident when 0.1M solutions were used. Serine, aspartic acid, and beta-hydroxyaspartic acid appeared in aerated solutions of threonine following irradiation. When serine was irradiated in the presence or absence of oxygen, aspartic acid appeared. (H.L.W.)

8703 ^{95}Zr AND ^{95}Nb IN HUMAN LUNGS AND ATMOSPHERIC DUST DURING 1963. Dutailly, L.; Martin, J.; Robert, J.; Burg, C. (Service Central de Protection contre les Radiations Ionisantes, Paris. Univ., Nancy). Nature, 212: 702-3(Nov. 12, 1966).

Activities of ^{95}Zr and ^{95}Nb were determined at Nancy, France, in atmospheric dust collected daily on filters and in lungs of area residents examined post-mortem. Experimental data were compared with values calculated from the ICRP theoretical model for pulmonary contamination. The average activities calculated by the ICRP formula agree with the average lung radioactivities measured in the study. (H.G.D.)

8704 SOFT TISSUE RETENTION OF ^{90}Sr IN THE BEAGLE. Atherton, David R.; Stover, Betsy J. (Univ. of Utah, Salt Lake City). Nature, 212: 703-4(Nov. 12, 1966).

Whole-body retention of ^{90}Sr was determined in adult beagles given a single intravenous injection. Uptake by non-mineralized tissues was calculated as percentage of injected dose per g of liver, kidneys, and spleen. Soft tissue retention of ^{90}Sr was very small and decreased with time, the contribution of these tissues to whole-body retention remaining constant from about 1000 days post-injection onward. It is suggested that the association of ^{90}Sr with soft tissues for long intervals following injection is controlled by the ^{90}Sr in the skeleton and diminishes as the skeletal reservoir is depleted. (H.G.D.)

8705 INDIRECT MEASUREMENT OF BONE RESORPTION. Jowsey, Jenifer (Mayo Clinic, Rochester, Minn.). J. Clin. Endocrinol. Metab., 25: 1408-11(Oct. 1965).

Interpretation of bone resorption by indirect measurements with radiocalcium and other bone-seeking isotopes is discussed. The interpretation of the slope of the specific activity curve of tracer deposition in bone as a measure of bone resorption is questioned. Data from results with human material after an in vivo exposure to a calcium isotope at high specific activity and from humans who have had radium-226 in their skeleton for 30 yr were used to support the discussion. Values for new bone formation labeled at high specific activity and for bone resorption obtained by using unlabeled material revealed that formation and resorption takes place in the adult at the rate of about 3% per year. This percentage was deemed far too low to support the assumption that within 10 days any bone of high specific activity could be resorbed and that the break in the slope of the curve could not be regarded as a function of resorption. (TSS)

8706 WATER PERMEABILITY OF PLANT CELLS. Huebner, Gerhard (Institut fuer Stabile Isotope, Leipzig). Protoplasma, 60: 402-25(Nov. 4, 1965). (In German).

The exchange of tissue water of roots with water in the surrounding medium proceeds at the same velocity that water is removed from the roots by hypertonic solutions. As measured by deuterated water (D_2O) the exchange velocity is not altered in hypertonic solutions. This process was studied in plasmolyzed cells from Vicia faba plants, where it was demonstrated the exchange was completed with a half time of 90 sec. In contrast to this, roots that had been

pretreated with a hypertonic solution exchanged D_2O with a half time of 12 to 15 sec. The exchange of tissue water in nonplasmolyzed roots followed a first-order reaction time course, suggesting possibility of a diffusion mechanism. In contrast to this, the exchange in roots pretreated with a hypertonic solution was initially rapid and then decreased. The initial rate was close to the half value of free diffusion of water, while the second rate was greater than the exchange rate for tissue water in normal roots. From these data it appeared that in the roots pretreated with hypertonic solutions the exchange of the water present outside of the plasmolyzed protoplasts proceeded with a velocity that corresponded to that of free diffusion of water, while the water in the plasmolyzed protoplasts and in the vacuoles was exchanged more slowly than in unplasmolyzed cells. This indicated that the main barrier to permeation was in the protoplasts. (BBB)

8707 ELECTRON MICROSCOPIC AUTORADIOGRAPHY OF RADIOIODINE (^{131}I) IN THE THYROID GLAND. Lupulescu, A.; Petrovici, Al. (Inst. of Endocrinology, Bucharest). Acta Biol. Med. Ger., 16: 86-94(1966).

Investigations were carried out with compound-light and electron microscopes to determine localization and kinetics of ^{131}I in the thyroid gland of rats. Male rats that weighed from 180 to 200 g were given an intraperitoneal injection of 0.8 mC ^{131}I and sacrificed after 6 hr. A massive accumulation of radioiodine was observed within the follicular colloid; lesser amounts of radioactivity were found in the adjacent apical vesicles, ergastoplasmic sacs, secretion droplets of the Golgi zone, and interior of the nucleus. Accumulation had not occurred in the basal zone or in the vicinity of the blood capillaries. These data support the concept that the iodination of thyroglobulin (thyroid hormone) with radioiodine occurs almost entirely in the follicular colloid: the iodinated thyroglobulin, after enzymic proteolysis, is resorbed by pinocytosis via the microvesicles adjoining the apical border. Therefore, it was considered that the secretory droplets may contain resorbable iodinated thyroglobulin and not newly synthesized protein. In contrast to earlier findings, the present investigation showed that after 6 hr, most of the ^{131}I was distributed within the follicular colloid and to a lesser degree in the apical zones. (BBB)

8708 ON THE PHARMACOLOGY OF THE METALS OF THE FOURTH SUBGROUP OF THE PERIODIC SYSTEM. Trapmann, Heinz; Devani, Muljibhai (Univ., Munich). Pharm. Ztg. Ver. Apotheker-Ztg., 110: 31-4(Jan. 1965). (In German).

Pharmacological applications of group IVB, especially Th, are reviewed. General properties of Th and its effects on biological material are mentioned, particularly blood. The absorption of Th after intravenous injection and effects of intravascular injection of colloidal ThO_2 are discussed. Effects of intracranial arteriography and extensive application of Th X are enumerated. The indications of the following Th containing pharmaceutical preparations: Doramad toothpaste, Th X Buchler, Thoros, Thovitur D, Th X Auer, Th X Devea, Thoroxyl, Ixthor Buchler, Peteosthor, Umbrathor, and Thorotrast, are given. Comparison of in vitro and in vivo experiments is discussed, as are phosphatic activity of Th and the relations between Th and tumor development. A review of the factors noted in the latter topic is given. Most of the 63 references cited are concerned with applications of Th. (BBB)

8709 QUANTITATIVE STUDY OF THE DISTRIBUTION OF ^{198}Au DURING EXPERIMENTAL PLASMOCYTOSIS FROM DDT. Fumarola, Donato; Giordano, Domenico; Pantaleo, Romeo (Univ., Bari, Italy). Sangre, 9: 127-30(1964).

The incorporation of colloidal ^{198}Au by the reticuloendothelial system (RES) of rabbits and rats was studied under various conditions. An increase in plasma cells was induced by intramuscular injection of 100 mg/kg DDT (1,1,1-trichloro-2,2-bis(p-chlorophenyl)ethane). In the rat, plasma cells were most markedly increased in thymus, bone marrow, and liver, and in the spleen in the rabbit. A 50-μCi dose of ^{198}Au was injected intravenously. In normal rats the order of uptake of ^{198}Au by various tissues was: liver > thymus > bone marrow > spleen. DDT injection reduced the ^{198}Au uptake in all organs except spleen. In normal rabbits ^{198}Au was distributed as follows: liver > spleen > bone marrow > thymus. After DDT treatment of rabbits, only spleen showed a diminished incorporation of the isotope. The intensity of plasma cell infiltration of the various organs generally correlated with a reduction of uptake of colloidal ^{198}Au by the organs. (BBB)

8710 EFFECT OF PROTEIN SOURCE IN THE DIET ON ^{65}Zn ABSORPTION AND EXCRETION BY CHICKENS. Edwards, Hardy M. Jr. (Univ. of Georgia, Athens). Poultry Sci., 45: 421-2(Mar. 1965).

Retention of radiozinc was examined in Plymouth Rock cockerels, 28 days old, fed a casein-gelatin or corn-soybean meal ration. Whole-body counting was performed 6 to 245 hr after intraperitoneal injection or feeding 0.1 μC ^{65}Zn. There was only a slight difference in the retention of the intraperitoneally administered ^{65}Zn between chicks receiving the two diets. These data indicated that the total biological half life of endogenous ^{65}Zn was ~20 days under the experimental conditions that existed. Chicks receiving the casein-gelatin diet absorbed a much greater amount of the orally administered ^{65}Zn than those receiving the soybean protein diet. The plateaus of the oral dose curves were extrapolated back to zero day to give some estimation of the percent of the dose that was absorbed. These extrapolations indicated that 9% of the dose was absorbed by the chicks receiving the soybean protein diet, while 16% was absorbed by those receiving the casein-gelatin diet. (BBB)

8711 ACUTE RADIATION INJURY AND ENZYME ACTIVITY. Tanka, D.; Keller, Maria (National Inst. for Rheumatism and Balneology, Budapest). Acta Morphol. Acad. Sci. Hung., Suppl. 13: 43(1965).

It was proposed that changes of enzyme activity occurring under the effect of ionizing radiation play a significant role in the development of late radiation injury, genetic injury, and tumor formation. According to the reported histochemical and biochemical findings, the activity of an enzyme may decrease in some organs and increase in others. This might be due to differences in radiation sensitivity of the apoenzyme. (BBB)

8712 CHANGE IN PROPERTIES OF BONE-MARROW DNA AFTER X IRRADIATION IN VIVO. Kritskii, G. A.; Malysheva, L. F.; Safronova, R. N. (Moscow State Univ.). Biokhimiya, 30: 1147-52(Nov.-Dec. 1965). (In Russian).

Local x irradiation (2,000 R) of the hind leg of rabbits caused a decrease of the viscosity of bone marrow DNA immediately after exposure, the maximum decrease (49%) occurring on the 3d day. The method of fractional precipitation of DNA with trichloroacetic acid from an alkaline solution or with alcohol in a neutral medium containing Mg revealed a slight increase in the readily precipitable DNA (fraction I) immediately after exposure. This fraction decreased 4- to 5-fold during the period of acute radiation injury to the tissue. The molecular weight of the fraction increased immediately after exposure but decreased 3 days later. It was concluded that the decrease in viscosity and increase in precipitability of DNA immediately after x irradiation may have been caused by the combined processes of depolymerization, formation of cross-linkages in DNA molecules, and dissociation of complexes of DNA with RNA and protein. Depolymerization of DNA was most pronounced during the period of acute radiation injury (1 to 5 days after irradiation). These changes eventually proved to be reversible for the most part. Electron microscopic studies revealed aberrant forms of DNA structures, such as cross-linkages, branching, twisting of strands, depolymerization, and formation of knots. (JPRS)

8713 DEPENDENCE OF RENAL CLEARANCE OF RADIOIODIDE ON SEX, AGE, AND THYROIDAL STATUS. Oddie, T. H.; Meade, J. H. Jr.; Myhill, J.; Fisher, D. A. (Univ. of Arkansas, Little Rock, Royal North Shore Hospital of Sydney, New South Wales). J. Clin. Endrocrinol. Metab., 26: 1293-6 (Dec. 1966).

Data on the renal clearance rate (k_2) for radioiodine have been analyzed statistically for 2 patient populations, Australian (1335 subjects) and United States (474 subjects), to establish whether significant differences are related to the sex, age or thyroidal status of the subject. In both groups there was a significant decline of k_2 with age (about 0.7%/yr) and a significant lowering with both hypothyroidism (13-30%) and hyperthyroidism (9-16%). The value of k_2 was lower in males than in females (9%, significant in the Australian group; 3%, not significant in the U. S. group). The average values of k_2 were not very different for the 2 patient populations in spite of a wide difference in the mean dietary intake of iodine. (auth)

8714 EXCISION OF PYRIMIDINE DIMERS FROM IRRADIATED DEOXYRIBONUCLEIC ACID IN VITRO. Carrier, W. L.; Setlow, R. B. (Oak Ridge National Lab., Tenn.). Contract W-7405-eng-26. Biochim. Biophys. Acta, 129: 318-25(Nov. 22, 1966). (ORNL-P-1813).

An extract of cells of Micrococcus lysodeikticus is able to excise thymine-thymine and cytosine-thymine dimers from ultraviolet-irradiated deoxyribonucleic acid. The rate of excision is greater than the rate of hydrolysis of the deoxyribonucleic acid. Dimers excised from the deoxyribonucleic acid appear as parts of acid-soluble oligonucleotides which seem to have one terminal phosphate group. The excision in vitro is similar to the reaction observed in vivo in ultraviolet-resistant cells and is probably one of the steps in the dark repair of the biological activity of irradiated deoxyribonucleic acid in vitro. (auth)

8715 CATECHOLAMINE METABOLISM IN THE SYMPATHETIC GANGLION DURING STIMULATION OF THE PREGANGLIONIC FIBERS IN IRRADIATED ANIMALS. Klimovskaya,

L. D.; Maslova, A. F. Byull. Eksp. Biol. Med., 42: No. 7, 38-41(July 1966). (In Russian).

Free and associated fractions of noradrenaline, adrenaline, and oxidation products of adrenaline were determined in the superior sympathetic ganglion of rabbits exposed to whole-body gamma doses of 400 R. Noradrenaline content increased, while adrenaline content increased. Stimulation of the preganglionic fibers in the controls resulted in a decreased amount of catecholamines. The content of noradrenaline fractions that were not oxidized increased in irradiated animals. (H.G.D.)

8716 THYROID AND METABOLISM OF CALCIUM AND PHOSPHORUS. I. THE KINETICS OF ^{45}Ca IN THYROTOXICOSIS. Scandellari, C.; Conte, N.; Macri, C.; Federspil, G. (Univ., Padua). Acta Isotop., 5: 369-79(1965). (In Italian).

The kinetics of ^{45}Ca metabolism were studied in ten patients with hyperthyroidism. Calcium turnover in bones and the urinary and fecal excretion of calcium were increased. Augmentation of exchangeable calcium pools fluctuated. (auth)

8717 LOSS OF LIGHT ENERGY IN RETINA AND CHOROID. Geeraets, Walter J.; Williams, R. C.; Chan, Guy; Ham, William T. Jr.; Guerry III, Du Pont; Schmidt, F. H. (Medical Coll. of Virginia, Richmond). Arch. Ophthalmol. (Chicago), 64: 606-15(Oct. 1960).

Basic data were sought concerning flash blindness and chorioretinal burns because of the eye hazard from nuclear weapons and because of the development of light coagulation of the retina as a clinical tool in ophthalmology. Knowledge of the spectral absorption characteristics of the ocular fundus is needed for realistic evaluation of the retinal burn capabilities of nuclear weapons. This problem is not related directly to visual sensitivity, since only a small portion of the energy incident on the retina is absorbed by the retinal layers anterior to the pigment epithelium. Thermal lesions result from selected absorption in the pigment epithelium and in the vascularized and pigmented choroid. The method used consisted in measuring percentage transmission through the freshly enucleated whole human and rabbit eyes and comparing this with percentage transmission through the ocular media with retina and choroid removed. Results showed that absorption of radiant energy by the fundus of rabbit and man occurs primarily in the spectral range 400 to 1000 μ, the peak absorption occurring at ~575 μ. Light absorption in the ocular media and fundus of the medium-to-darkly pigmented rabbit is similar to that in man, making the rabbit an excellent test animal for investigation of thermal hazards to the retina. Energy absorption in the rabbit fundus depends primarily on the degree of pigmentation in the pigment epithelium and choroid. (BBB)

8718 MOLECULAR EVENTS RESULTING IN RADIATION INJURY, REPAIR, AND SENSITIZATION OF DNA. Szybalski, Waclaw (Univ. of Wisconsin, Madison). J. Ark. Med. Soc., 62: 488-94(Apr. 1966).

A model is proposed which would permit unifying all the data pertaining to the lethal effects of x rays on DNA, phages, and cellular organisms. DNA as a whole is the principal target of lethal radiation effects. Two distinct targets can be experimentally detected in the DNA molecule: the phosphate ester bond and the pyrimidine nucleotides. Three different radiation mechanisms can be distinguished: reaction 1, direct hits resulting principally in fission of phosphate ester bonds (DNA strand breakage); reaction 2, an indirect reaction independent of the presence of oxygen and proceeding through radicals $\dot{R}_1$ (this reaction also results in DNA strand breakage); and reaction 3, an indirect, oxygen-dependent reaction proceeding through radicals $\dot{R}_2$ and resulting in chemical modification of nucleotides, predominantly the pyrimidines. The relative lethalities of reaction 1, 2, and 3 depend on the conditions of irradiation. In fully unprotected aqueous media, reaction 2 plays the most decisive role. Practically all the lethal events could be accounted for by double-strand (phage) or single-strand (transforming DNA) DNA breaks, the latter as inferred from the effects of DNase. Damage to tail fiber protein could be experimentally assessed, since it prevents irreversible absorption of the phages. Addition of a radical scavenger of the histidine type suppresses only reaction 2. Thus, in well oxygenated, histidine-supplemented buffer or in nutrient broth, the oxygen-mediated reaction 3 accounts for up to 60% of the lethal events, whereas DNA strand breakage contributes to the remaining 40% of the lethality. It is not clear whether production of the reactive species $\dot{R}_2$ depends on the presence of oxygen, or whether oxygen reacts with the pyrimidine converted into the active state, which event results in irreversible radiochemical damage. Under anoxic conditions and in the presence of radical scavengers both reactions 2 and 3 are suppressed, with reaction 1 playing the principal role. (BBB)

8719 THE EFFECT OF IONIZING RADIATION ON THE SYNTHESIS OF PROTEIN IN THE NUCLEI OF TISSUE CELLS OF RATS. Blokhina, V. D.; Romantsev, E. F. (Inst. of Biophysics, Ministry of Public Health, USSR). Dokl. Akad. Nauk SSSR, 168: 454-5(May 11, 1966). (In Russian).

Rats were given a minimum absolutely lethal gamma dose of 850 R, and cell nuclei were isolated from the spleen, liver, and mucous membrane of the small intestine within 1 hour after the irradiation. The cells were incubated with ^{14}C-alanine for 5, 15, 30, and 60 min in a sugar-phosphate buffered medium. The protein fraction was isolated and counted for activity. A significant decrease in the accumulation of radioactivity in proteins of spleen cells was noted as a result of irradiation. On the other hand, increases in the rate of incorporation of ^{14}C-alanine were observed in the irradiated liver and mucous membrane cells. This behavior of the various kinds of cells can be roughly correlated with the radiosensitivities of the cells. (TTT)

8720 INFLUENCE OF VESICULAR-ARBUSCULAR MYCORRHIZAS ON THE UPTAKE OF ^{32}P BY LIRIODENDRON TULIPIFERA AND LIQUIDAMBAR STYRACIFLUA. Gray, L. E.; Gerdemann, J. W. (Univ. of Illinois, Urbana). Nature, 213: 106-7 (Jan. 7, 1967).

Results of experimental work described indicate that vesicular-arbuscular mycorrhizas enhance uptake of ^{32}P by the host plant from nutrient solution and from soil, and that the function of vesicular-arbuscular mycorrhizas is similar to that of ectotrophic mycorrhizas. (U.K.)

8721 RELATIONSHIP OF ^{137}Cs HALF-LIFE IN HUMANS TO BODY WEIGHT. Eberhardt, L. L. (Battelle Memorial Inst., Richland, Wash.). Health Phys., 13: 88-90(Jan. 1967).

The time required for half of a given amount of ^{137}Cs to be eliminated from the body was widely investigated, and a considerable range of half-times were observed, with some evidence of a relation to age. Studies of radionuclide half-times in other organisms suggest a close relationship to a fractional power of body weight, a finding that is in general accord with a wide variety of metabolic rates. Whether a similar relation may hold for ^{137}Cs in humans, and if so its use in interpreting available data were studied. Results suggest that the relation half-time = 6 $w^{\frac{1}{4}}$ may serve as a rule of thumb for ^{137}Cs in humans. Various modifying factors are discussed. (U.K.)

8722 ACCUMULATION OF ^{65}Zn FROM PROLONGED CONSUMPTION OF COLUMBIA RIVER FISH. Foster, R. F.; Honstead, J. F. (Battelle-Northwest, Richland, Wash.). Health Phys., 13: 39-43(Jan. 1967).

Fish caught downriver from the Hanford reactors were eaten once each week for more than 1 year in order to provide reasonable estimates of the quantity that might be consumed by persons living in the environs and the associated intake of ^{32}P and ^{65}Zn. In a 12-month period approximately 25 lbs of fish were consumed amounting to about 3000 nCi ^{32}P and 800 nCi ^{65}Zn. The accumulation of ^{65}Zn in the consumer was measured each week in a whole-body counter in order to trace the build-up and follow the seasonal trend. A maximum body burden of about 130 nCi ^{65}Zn was reached on day 104 and again on day 310. After the initial build-up toward equilibrium, the body burden approximated seven times the weekly intake, more than anticipated from some published data. The reduction of ^{65}Zn body burden following the last meal of Columbia River fish was observed for 511 days, indicating an effective half-life of 162 days. (auth)

8723 THE AUTORADIOGRAPHIC DETECTION OF IONS IN PLANT TISSUES. Gahan, P. B.; Rajan, A. K. (King's Coll., London). J. Exp. Bot., 17: 34-43(Feb. 1966).

An improved method is presented for following the incorporation of radioisotopes in plant cell components, after an assessment is made of earlier autoradiographic techniques for the examination of the subcellular localization of ions in plant cells. Studies were conducted with six-day-old seedlings of Vicia faba placed for 14 hr in a balanced nutrient solution which contained 0.5 mM of sulfate and 1 μC/ml of $^{35}SO_4$. The plants were then removed from the radioactive nutrient solution, and prepared for sectioning. For autoradiography, the apposition technique gave only qualitative data since the resolution at the subcellular level was less than that of the direct-contact method. With direct autoradiography, satisfactory results were obtained using untreated plants fed with $^{35}SO_4$ or by a modification involving the drying of the sections. If, during the exposure period, any slight thawing of the section had occurred, it was possible to detect this by examination of the autoradiographs when the diffused $^{35}SO_4$ showed as a heavy autoradiograph adjacent to the section. It was considered from the data obtained that a gross movement of ions between the adjacent tissues during the autoradiographic procedures was unlikely to have occurred. (TSS)

8724 RADIOACTIVITY OF HeLa CELLS GROWN IN THE PRESENCE OF TRITIATED THYMIDINE: INTERPRETATION

OF THE FINDINGS. Girgis, A.; Vieuchange, J. (Institut Pasteur, Paris). Ann. Inst. Pasteur, 110: 1-16(June 1966). (In French).

Factors influencing the incorporation of ^{3}H-thymidine by HeLa cell cultures were examined. The ^{3}H-thymidine preparations used consisted of a fresh preparation of ^{3}H-thymidine labeled in the methyl group by catalytic exchange, a four year old preparation, and either ^{3}H-thymidine-methyl or ^{3}H-thymidine freshly prepared by enzymatic conversion. Temperature and time of incubation were found to influence the results. At 1, 2, 3, and 4°C, radioactivity occurred only in the nucleus; about 90% was adsorbed and only 10% incorporated. At 15 and 37°C, approximately 80% of the material was incorporated and it occurred both in the nucleus and cytoplasm. At no instance were any Feulgen-positive loci detected in the cytoplasm. Radioactive materials incorporated into HeLa cells incubated at 15 or 37°C remained stable after 60 to 110 min of hydrolysis at 60°C with 1 N HCl. In HeLa cell cultures incubated at the lower temperatures, radioactivity was not observed after hydrolysis. Preliminary studies on the metabolic pathways of both thymidine moieties (thymine and deoxyribose) indicated that neither tritiated deoxyribose, which could be present in the thymidine labeled by catalytic exchange, nor the self-decomposition of tritiated thymidine had any influence on the results obtained. The possibility that tritiated thymidine was not a specific precursor of DNA was discussed. (BBB)

8725 STUDIES ON THE EFFECT OF CONTROLLED-RATE COOLING ON MARROW VIABILITY. Lewis, J. P.; Passovoy, M.; Trobaugh, F. E. Jr. (Presbyterian-St. Luke's Hospital, Chicago). Bibl. Haematol., No. 23, Pt. 3: 656-61(1965).

Methods for optimal preservation of bone marrow at low temperature were investigated, and a radiobiologic assay technique to assess marrow viability is described. Bioassay based on the colony-producing potential of hematopoietic tissue injected into lethally irradiated mice was developed. This assay is based on the observation that hematopoietic recovery in irradiated mice occurs as nodules of hematopoietic tissue in the spleen. These nodules are clones of hematopoietic cells and when postirradiation recovery is effected by the injection of hematopoietic cells, the number of nodules is related to the number of cells injected, providing the basis for a quantitative assay of repopulating potential. Femoral marrow was suspended in 12% glycerol and 4% serum and three samples of this marrow were cooled simultaneously at three different rates. Results showed that cooling marrow from room temperature to the freezing point and varying the rate of cooling from 0.8°C to 4°C/min does not affect marrow viability. Varying the supercooled prefreezing plateau from 0 min to 16 min does not affect marrow viability. The temperature at which freezing is initiated within a range of −8°C to −18°C does not affect the viability of the marrow suspension. Prolonging the post-freezing plateau, increasing the rate of cooling from 1°C/min to 24°C/min produces a significant reduction in the viability of the marrow. (BBB)

8726 PROBLEMS ON POSTRADIATIVE ALTERATIONS IN THE PENETRABILITY OF TISSUES. Alaverdyan, M. I.; Gambaryan, L. S.; Papoyan, S. A. Biol. Zh. Arm., 19: No. 5, 3-10 (May 1966). (In Russian).

The effects of x radiation on the activity of hyaluronidase ferments and monosaccharides of hyaluronic acid were experimentally studied in vitro and in vivo. The in vitro tests showed a linear dependence of the decreases of activity and viscosity of the hyaluronate solutions on the size of the radiation doses from 200 to 96,000 R. The hyaluronidase and monosaccharide of hyaluronic acid were determined in various organs of rats and mice exposed to x-ray doses of 200 to 10,000 R. The results showed the existence in the irradiated animals of a great dependence between the increase of the tissue permeability and the physiological condition of the system of hyaluronidase-hyaluronic acid. (J.S.R.)

8727 EFFECTS OF X IRRADIATION ON THE ANTIGENIC CHARACTER OF AGKISTRODON PISCIVORUS (COTTONMOUTH MOCCASIN) VENOM. Flowers, Herschel H. (Army Medical Research Lab., Fort Knox, Ky.). Toxicon, 3: 301-4(1966).

Cottonmouth moccasin venom with its necrotizing toxin inactivated 50 to 75 percent by x-irradiation was studied to determine the alteration of its antigenic character. Immune globulin of rabbits immunized with both normal and x-irradiated venom were compared. The globulin of rabbits immunized with x-irradiated venom showed little difference in its neutralizing titer from the globulin of rabbits immunized with normal venom. A group of animals immunized with normal venom suffered 20 percent mortality, sloughing of tissue, and severe local reactions around the area of injection. The group of rabbits immunized with x-irradiated venom suffered no mortality or sloughing of tissue. Local reactions around the site of injection were less severe. (auth)

8728 DOUBLE ISOTOPE TECHNIQUE FOR BLOOD VOLUME MEASUREMENT. Kornitzer, M.; Delcroix, C.; Cleempoel, H. (Hopital Saint-Pierre, Brussels). Rev. Franc. Etud. Clin. Biol., 11: 632-7(June-July 1966). (In French).

It is the purpose of this work to describe a double labeling technique for the study of rapid variations of the two blood phases, i.e., the plasma volume and the red blood cell volume. To trace these 2 phases ^{125}I labeled serum albumen and ^{51}Cr tagged red cells were used. Both isotopes are γ ray emitters; nevertheless they can be distinguished easily. Their spectra are the simplest ones; their photopeaks are located very far apart, and furthermore the fraction of the Compton spectrum of ^{51}Cr seen in the window set for ^{125}I is small (about 10 p. 100 of the events counted in the photopeak). All the samples had the same geometry and the same self-absorption; this has been checked by computing the counting efficiency of ^{125}I using the coincidence method in a single detector. We have injected simultaneously ^{51}Cr, tagged R.B.C. and ^{125}I labeled albumin into 11 normal subjects. The mean red blood cell volume was found to be 30.9 cc per kilogram of body weight, the mean plasma volume, 45.8 cc per kilogram and the total blood volume, (i.e., the sum of the components) 76.7 cc/kg. The proportion of R.B.C. computed from the total blood volume and the red blood cell volume is called "whole body hematocrit." The ratio of the whole body hematocrit and peripheral venous blood hematocrit (F cells) was 0.90. (auth)

8729 ^{45}Ca METABOLISM IN THE BONY CALLUS DURING HEALING OF FRACTURES OF THE LONG BONES. Popov, M. M.; Kuznetsov, N. I. (Yaroslavl Medical Inst., USSR). Federation Proc., Transl. Suppl., 25: T895-6(Sept.-Oct. 1966).

Translated from Med. Radiol., 10: No. 10, 34(1965).

The incorporation of ^{45}Ca was considerably increased in the bony callus developing after a fracture, and prolonged fixation of the isotope in the callus was observed. Nine weeks after the fracture, incorporation of the radioactive calcium into the callus was less intensive. The total calcium content in the bony callus was very slightly reduced during the first 5 weeks on account of its low degree of compactness. With the definitive formation of the bony callus and its regression, its calcium content approximated that found in the symmetrical area of bone in the intact limb. The results of this investigation demonstrate the need for further study by the isotope method of the healing of fractures sustained under different conditions. (auth)

8730 STUDIES ON DOGS AND MICE OF METABOLISM OF AQUEOUS SOLUTIONS OF RADON. Pincet, J.; Allain, P. J. Radiol., Electrol. Med. Nucl., 47: 429-30(Aug.-Sept. 1966). (In French).

Absorption and excretion of aqueous solutions of radon were studied in dogs given duodenal injections from a source containing 25 mm^3/l Rn and in the feces of mice. Radon measurements were made in blood, urine, and expired air of dogs. It is concluded that the greater part of the Rn crosses the wall of the digestive tract by diffusion, passes into the blood, and is eliminated essentially at the level of the pulmonary alveoli. (tr-auth)

8731 EFFECT OF IONIZING RADIATIONS ON STARCH. EFFECTS OF GAMMA RADIATION AT THE DOSE OF 30 MR IN THE STARCH OF POTATOES AS A FUNCTION OF THEIR WATER CONTENT. Reuschl, H.; Guilbot, A. (CERDIA, Massy, France). pp 209-23 of Applications des Rayonnements en France. Vol. I. Gif-sur-Yvette, France, Centre d'Etudes Nucleaires de Saclay, 1966. (In French).

The effect of the water concentration on reactions induced by 30 MR γ radiation in potato starch was studied, taking into consideration available data on the fixation state of the water by the starch. Three aspects of the irradiation effect were analyzed. A total characterization was made of the irradiated starch in order to show the principal types of modification. The nature of the modified glucose units in the polyosidic chain was examined. The low-molecular-weight degradation products were studied in order to identify them and determine substances capable of representing the last terms of a type of degradation. The results obtained were compared with previous results. Three modes of intervention of water on the radiolytic reactions of starch were detected. The first was a protective effect with respect to oxidation reactions that was more marked when the hydration was low. There was also also a protective effect with respect to chain rupture reactions that was evident only at water concentrations above 21%. Water intervened chemically in the formation of glucose, whose concentration increased at a water concentration of approximately 10%. (J.S.R.)

8732 CONTENT OF ^{90}Sr AND ^{137}Cs IN AGRICULTURAL PRODUCTS DURING 1963 AND 1964 IN WEST SLOVAKIA. Chupka, Sh.; Petrashova, M.; Tsarakh, I. (Regional Sanitation Epidemiological Station, Bratislava). At. Energ. (USSR), 21: 197-201(Sept. 1966). (In Russian).

Analysis of the ^{90}Sr and ^{137}Cs level in agricultural products in West Slovakia during 1963 and 1964 showed the highest content of

these isotopes in grain cultures comparatively lower content in leguminous, and the lowest in tuberous plants. The $^{137}Cs:^{90}Sr$ ratio depended on the sorptive ability of plants and the amount of radioactive fallout in the vicinity of nuclear power plants of the region. (tr-auth)

8733 HYDROGEN–DEUTERIUM EXCHANGE IN HEAVY MEROMYOSIN. Willumsen, Lars (Carlsberg Lab., Copenhagen. Univ., Copenhagen). Biochim. Biophys. Acta, 126: 382-8 (Oct. 10, 1966).

The exchange of peptide hydrogens with deuterium was followed by measuring the decrease of the amide II band at 1542 cm^{-1} for heavy meromyosin. Heavy meromyosin contains a relatively large number of slowly exchanging peptide hydrogens that decrease with increasing pH in the pH range 5.5 to 10.8. The mechanism of the hydrogen isotope exchange between protein and solvent water is described in terms of Hvidt's model, where rapid equilibrium between a closed and an open molecular conformation is assumed and where only the open form is expected to exchange. (auth)

8734 BLOOD SERUM GAMMA-GLOBULINS AS INDICATORS OF INSUFFICIENCY OF NATURAL ULTRAVIOLENT RADIATION. Devyatka, D. G. (Vinnitsa Inst. of Medicine, USSR). Gig. Sanit., No. 6, 103-4(June 1966). (In Russian).

Gamma globulin fractions of blood serum react to changes in the amount of ultraviolet radiation of solar light and can be used as an indicator of the amount of ultraviolet radiation received by the organism. In the absence of ultraviolet radiation, there is a persistent reduction of gamma globulin levels in the blood serum. (tr-auth)

8735 THE EFFECT OF ACUTE INFLAMMATION ON THE UTILIZATION AND DISTRIBUTION OF TRANSFERRIN-BOUND AND ERYTHROCYTE RADIOIRON. Quastel, Michael R.; Ross, Joseph F. (Univ. of California, Los Angeles). Contract AT(04-1)GEN-12. Blood, 28: 738-57(Nov. 1966). (UCLA-12-563).

In rats with acute turpentine-induced inflammation, there was a reduced reutilization of radioiron from transfused senescent erythrocytes but a normal utilization of transferrin-bound ^{59}Fe after a 40-hour period. There was a pronounced retention of tracer from the nonviable red cells by the livers and spleens of the inflamed animals. During inflammation, the plasma iron turnover fell by about 50 percent, while the fraction of plasma iron removed per hour was increased. However, there was no marked change in the relative distribution of transferrin-bound ^{59}Fe to the liver, spleen, and bone marrow (after perfusion). Transferrin-bound ^{59}Fe initially appeared at an increased rate in the circulating red cell mass. Following administration of ferric ammonium citrate in order to raise the plasma iron level, there was a rise in the plasma iron turnover of the inflamed rats, in contrast to the control animals. Diversion of radioiron to the liver and spleen was not markedly increased under these conditions. It is concluded that the immediate fall in plasma iron turnover and hypoferremia during acute turpentine inflammation results mainly from an inhibition of the release of iron derived from senescent red cells into the plasma. An increased avidity of the liver, and of marrow red cell precursors and/or reticulocytes for plasma iron may accentuate the fall in plasma iron levels. There appeared to be no inhibition of the bone marrow capacity to turn over larger amounts of plasma iron during inflammation. Results may help in the interpretation of disturbances of iron metabolism during the acute inflammatory state. (auth)

8736 BETA RADIOACTIVITY OF WOOD-RINGS OF SPRUCES IN LOWER SILESIA AREA. Kobelak, Antoni (Univ., Wroclaw); Rozenfeld, Bronislaw; Urbanowski, Edward; Wesolowski, Jan; Dabek, Antoni. Nukleonika, 11: 511-15(1966). (In Polish).

The relative, gross beta activity of annual rings of freshly felled spruces was measured as a function of the age of the rings. Maxima of the activity were found in rings from the growth seasons in 1945 to 48 and 1959 to 63. The shape of the maxima curves can be explained by the transverse diffusion of radioactive substances in the living tree. Strontium-90 and ^{90}Y contamination in annual rings of spruces was noted. (auth)

8737 THE INFLUENCE OF VMT [TOBACCO MOSAIC VIRUS] ON THE ABSORPTION AND DISTRIBUTION OF P IN THE TOBACCO PLANT. Savulescu, Alice; Esanu, V.; Balif, Gabriela; Hurghisiu, Ileana. Stud. Cercet. Inframicrobiol., 16: 527-31 (1965). (In Rumanian).

In an experimental study, the authors found that infection with tobacco mosaic virus partially inhibits phosphorus. In the early phase of the uptake by roots there are no changes in the distribution of phosphorus among the various phosphorus compounds. In sick plants the isotope was accumulated to a greater extent in the nucleic acids and a lesser extent in the acid-soluble compounds, as compared to healthy controls. (auth)

8738 MACROMOLECULAR STRUCTURE OF THE DESOXYRIBONUCLEO-PROTEIN OF HEMOPOIETIC TISSUE OF MICE SUBJECTED TO ISOLATED OR FRACTIONED γ IRRADIATION. Grigorovich, N. A. (Inst. of Experimental Pathology and Therapy, Academy of Medical Sciences, USSR). Dokl. Akad. Nauk SSSR, 167: 1171-4(Apr. 11, 1966). (In Russian).

White mice were given a single gamma dose of 600 R, and five gamma doses of 400 R with a period of 30 days between irradiations. Immediately after irradiation and 1, 10, and 20 days after the irradiation, the mice were killed, and a DNP fraction was extracted from the spleen with a 1M NaCl solution. The DNP was not reprecipitated in order to preserve its native state. The formation and relaxation of the oriented DNP strands were observed by a method proposed by Spitkovskii. The DNP molecule shows elastic deformation as contrasted to the DNA molecule which does not deform. The DNP strands with a length of 5.8 to 8.2 cm were formed under standard conditions. The DNP strands from mice given a single dose of 600 R showed a contraction of 45% immediately after irradiation as compared with a contraction of 31% in the controls. A shift in macromolecular structure was also observed immediately after irradiation in mice subjected to multiple doses of irradiation. One day after irradiation and later, the deformation in the irradiated mice was less than that observed in the controls, and the macromolecular structure of the irradiated DNP did not differ substantially from that of ordinary DNP. (TTT)

8739 FORMATION OF FREE RADICAL STATES IN ANIMAL LIVER INDUCED BY γ RADIATION AND RADIOTOXINS OF LIPID NATURE. Baltbardzys, Z. Ya.; Kozlov, Yu. P.; Kudryashov, Yu. B.; Taranenko, G. A. (Moscow State Univ.). Dokl. Akad. Nauk SSSR, 167: 209-11(Mar. 1, 1966). (In Russian).

The highly reactive free radicals which exert strong influence on the course of processes in living organisms, are among the most important intermediate products of ionizing radiation; therefore, the kinetics of their formation in the liver of irradiated animals was examined and their effect was compared with that of lipid-type toxic materials on unirradiated animals. Rabbits and mice were subjected to a single, 800-R γ radiation; the toxic lipids were administered intraperitoneally. The presence of free radicals in the liver was determined by the copolymerization of ^{14}C-labeled acrylamide and propionamide, using the kinetic isotopic method. The results indicated that the biologically active lipids introduced into the liver are present there in the form of free radicals. After irradiation, the radiotoxic free radical concentration increased by a factor of 5 to 6. It was also found that radiotoxins are able to induce the formation of free radicals in the tissue of unirradiated animals, imitating the effects of radiation sickness. (TTT)

8740 ERYTHRON-DEPENDENT MODEL OF IRON KINETICS. Nooney, Grove C. (Univ. of California, Berkeley). Contract W-7405-eng-48. Biophys. J., 6: 601-9(Sept. 1966). (UCRL-16406(Rev.)).

A mathematical model presented of steady-state iron kinetics in the human explicitly displays the influence of the maturative and proliferative behavior of erythrons (erythrocytes or their precursory cells). Based on a compartmented iron kinetics scheme, the model is in the form of a system of linear integro-differential equations and describes the distribution of administered radioactive tracer as a function of time. Erythron behavior is characterized by three functions specifying iron uptake, proliferation, and survival. Simulative uses of the model are discussed and illustrated by an example. (auth)

8741 THE DISTRIBUTION OF ^{233}Pa IN THE ORGANISM OF RATS IN ENDOTRACHEAL, SUBCUTANEOUS, AND PERORAL INTRODUCTION. Zalikin, G. A. Med. Radiol., 11: No. 8, 67-70(Aug. 1966). (In Russian).

Upon administration with a citrate solution with pH 3 the main quantity of ^{233}Pa is deposited in the skeleton (up to 40–50%) and in the liver (from 4 to 11%). The isotope circulates in the blood for a prolonged time. ^{233}Pa is poorly absorbed from the gastrointestinal tract (0.006–0.02%), but rapidly and completely absorbs from the subcutaneous cellular tissue. Upon endotracheal introduction ^{233}Pa protractedly is retained in the lungs—34% after 6 hours after administration and 9.6%—129 days after the introduction. (auth)

8742 TECHNIQUE OF DETERMINING THE EFFECTIVE PERIOD OF HALF-DECAY OF IODINE IN THE THYROID GLAND. Oskotskii, L. I. Med. Radiol., 11: No. 8, 24-8(Aug. 1966). (In Russian).

For the characteristics of the thyroid function the author recommends to use more widely the index—effective period of radioiodine half-decay in the thyroid gland (T_{eff}). This index does not depend on the technique of radiation measurement in the thyroid gland, on the quantity of radioiodine introduced and on the type of apparatus used for the measurement. For determining T_{eff} the author proposes to measure the radiation

from the thyroid gland in similar conditions with a time interval of two days. Proceeding from the fact that reduction of radiation from the thyroid gland after two days in the overwhelming majority of persons proceeds with a constant rate (i.e., is connected with the exponential dependence) the author calculated a table for determining T_{eff} with an accuracy up to 0.1 day. According to this table T_{eff} is determined by the partial derivative from the division of two figures, expressing radiation from the thyroid gland, measured with a two-day time interval. On the basis of the proposed method and table the author determined T_{eff} for the group of healthy persons (104 men) in a goiter-endemic region (Primorsky Territory). In this group of persons T_{eff} comprised 7.7 ± 0.13 days, this being correspondent with the biological half-life period of radioiodine from the thyroid gland—205 days (fluctuations from 34.6 days to ∞). (auth)

8743 AN ELECTRON SPIN RESONANCE STUDY OF THE INTERACTION OF IRRADIATED DNA AND CYSTEAMINE. Milvy, Paul. Ithaca, N. Y., Cornell Univ., 1966. 189p.

Thesis.

Samples of DNA and 10% by weight of cysteamine were dissolved in doubly distilled water, dried, and sealed in glass tubes under vacuum. They were irradiated with 1.5 Mrad of 60 kvp X rays at 100°K and while at this temperature, placed in an X-band e.s.r. spectrometer. After the first derivative and total absorption spectra were recorded, the sample was annealed for four minutes at a somewhat higher temperature and the spectra again recorded. This procedure was repeated until a temperature of 373°K was achieved. The spectrum of irradiated cysteamine above 220°K is easily distinguished from the spectrum of irradiated DNA. A technique is used whereby the number of cysteamine spin centers and the number of DNA spin centers as well as the total number of spin centers in the irradiated sample may be computed. These quantities when plotted against annealing temperature reveal that at about room temperature a transfer of DNA spins to the cysteamine begins. This transfer results in the growth of the typical e.s.r. spectrum of the cysteamine free radical. At about 350°K, essentially all the spin centers are associated with the cysteamine and the spectrum is indistinguishable from the spectrum of pure cysteamine. The size of the spectrum is about 12 times the size expected from the irradiation of the small amount of cysteamine present in the sample, indicating that a large transfer of spins from the DNA to the cysteamine has occurred. The cysteamine spectrum persisted to 376°K. To understand the mechanisms responsible for this transfer of spins, cysteamine samples of denatured DNA, the DNA nucleotides, thymine, thymidine, RNA, deoxyribose-5′-phosphate, ribose-5′-phosphate, 2 deoxy-D-ribose, UMP, dUMP and 5methyl-dCMP were prepared. When the binary samples were prepared on an equimolar basis, only denatured DNA, TMP, the sugar phosphates and dUMP showed full transfer of spin to cysteamine. But two important differences from the native DNA-cysteamine were observed. The transfer to the cysteamine began at a temperature about 100°K lower, and above 338°K (the melting point of cysteamine) the spectrum disappeared. Partial transfer was observed in UMP, yeast, RNA and dGMP, while no transfer was observed in dAMP, 5-methyl-dCMP, dCMP, thymine, thymidine or D-ribose. An irradiated DNA-cystamine sample also showed partial transfer, but the spectral details were significantly different from the DNA-cysteamine sample and the spins recombined below 373°K although cystamine does not melt below this temperature. A DNA-methionine preparation did not result in spin transfer, consistent with the lack of protective activity of this compound in irradiated biological systems. Analysis of the spectra indicates that it is the reduced form of cysteamine that is involved in the transfer of spins in the system under study. Binding studies indicate that cysteamine binds to DNA and to the sugarphosphates. (Dissertation Abstr.)

8744 RANNIE RADIATSIONNO-BIOKHIMICHESKIE REAKTSII. (Early Radiation-Biochemical Reactions). Romantsev, E. F.; Koshchenko, N. N.; Blokhina, V. D.; Filippovich, I. V. Moscow, Atomizdat, 1966. 271p.

A bibliographic study is made of early radiation-biochemical reactions. The topics discussed are formation of H_2O_2, organic peroxides, and peroxide-like compounds by irradiation, effects of radiation and chemical protective agents on the biosynthesis of DNA, effects of ionizing radiation on the biosynthesis of RNA and possibility of its normalization by means of protectors, effects of ionizing radiation on the synthesis of albumin, and oxidative phosphorylation in tissues of living animals. (J.S.R.)

Ecology

Refer also to abstracts 8669, 8763, 8790, 8912, and 9020.

8745 (COO-1495-1) INVESTIGATIONS OF Ca–Sr ADSORPTION SELECTIVITY IN CLAYS AND SOILS. Khasawneh, F. E.; Barber, S. A. (Purdue Research Foundation, Lafayette, Ind.). Aug. 18, 1966. Contract AT(11-1)-1495. 9p. (CONF-660820-1). Dep. mn. CFSTI $1.00 cy, $0.50 mn.

From Annual Meeting of Soil Science Society of America, Stillwater, Okla.

Results of studies on calcium and strontium in 64 soils from Indiana make it possible to state the following conclusions: The range in selectivity of Ca–Sr exchange reaction in untreated soils is wider than has been reported so far. A six fold range is reported, 0.36–2.11. This range is narrowed down considerably by eliminating the effect of other exchangeable ions and of different levels of soluble salts. There is a negative correlation between selectivity coefficient and organic matter content. Destroying the organic matter of soil by H_2O_2 treatment resulted in a pronounced increase in Sr selectivity. Selectivity of a muck soil also indicated preference for Ca. The preference of soil organic matter for Ca over Sr is important in modifying the overall preference of soil for either of these ions. (H.L.W.)

8746 (ORNL-4007, pp 43-119) RADIATION ECOLOGY. Auerbach, S. I. (Oak Ridge National Lab., Tenn.).

The LD50-30 value for γ radiation was determined for six species of Cricetidae, two species of Muridae, and two species of Soricidae indigenous to Oak Ridge, Tennessee. The effects of acute γ irradiation on thymidine metabolism in indigenous rodents were measured using the thymidine analog 5-^{131}I-2′-deoxyuridine and Na ^{131}I as tracers. The effects of chronic low-level irradiation on the reproductive capacity of carp in White Oak Lake were studied using carp from Fort Loudoun Reservoir as controls. Examination of salivary gland chromosomes of 755 larvae from populations of Chironomus collected from White Oak Creek and White Oak Lake which had been exposed to an estimated radiation dose of 230 rads/yr for over 120 generations revealed 12 different aberrations not found in nonirradiated insects. The effects of γ radiation on viability, interspecific competition, and mutation induction were studied in laboratory populations of Drosophila. Two species of Pinus, white pine and shortleaf pine were exposed to fast neutrons at levels of 75, 100, 150, and 200 rads and measurements of radiation effects on growth and mortality indicated that white pine is more radiosensitive than shortleaf pine. The major activation products in soil samples exposed to 2056 rads of fast neutrons were identified as ^{56}Mn, ^{51}Cr, ^{86}Rb, ^{181}Hf, and ^{95}Zr–^{95}Nb. The effects of fast neutrons (505 and 1011 rads) on the uptake of ^{65}Zn and growth of three-year-old red oak seedlings were studied. Studies on the interactions of photoperiodic mechanisms and γ radiation that affect physiological processes were studied in the cocklebur (Xanthium). Clones of eastern cottonwood (Populus) propagated from cuttings and dormant cuttings were exposed to 7600 R γ radiation or mixed fast neutrons and γ at doses of 300 to 12,000 rads and maintained under constant environmental conditions. Growth measurements indicated an RBE of 10 to 12 for fast neutrons. An attempt was made to correlate radioinduced aberrations with changes in normal physiological processes in γ irradiated leaves. Year-to-year changes in the distribution of ^{137}Cs in a tagged Liriodendron forest were measured and accounted for in terms of major above- and below-ground transfers of ^{137}Cs. Data are included on foliage biomass, litter fall, primary productivity, and the distribution of ^{137}Cs in canopy food chains and myriapoda in the ^{137}Cs-tagged Liriodendron forest, the effects of temperature on ^{137}Cs metabolism in crustacea in the forest. Plants growing in the field were labeled with ^{86}Rb and ^{32}P and plant-insect relations of the chrysomelid beetle (Chrysochus) and the Indian hemp plant (Apocynum) and plant-to-insect concentration factors were measured. The translocation of radioisotopes in predator-prey systems was studied using ^{134}Cs-labeled brown crickets (Acheta) as the prey and a praying mantis (Tenodera), a centipede (Otocryptops), and lycosid spiders as predators. Results demonstrated a high accumulation of ^{134}Cs by predators during the feeding process. The distribution and retention of ^{106}Ru and ^{134}Cs in brown crickets (Acheta) were measured at various times after administration in drinking water. Data are included from studies on the losses of ^{137}Cs and ^{60}Co from three types of leaf litter (alder, white oak, and sycamore) in natural environments with varied rates of leaching (forest floor, pond, and stream), and the transfer of ^{137}Cs in terrestrial microorganisms in decomposing leaf litter; measurements were made of vegetation masses, litter, the content of carbon and nitrogen in humus, population densities of bacteria, fungi, and arthropods, respiration rates, moisture content and pH of litter and soil in each of four stages of sucession during the 5th, 7th, and 9th years after planting of kudzu vine (Pueraria) on cultivated and fertilized strips of a denuded landscape; the movement of ^{137}Cs in moss, lichen, litter, and plant rosettes of pine forest floors; and mechanisms of ^{60}Co sorption on clay soils. The line intercept and the point analysis techniques for the determination of basal cover estimates of vegetation for ecological studies were compared. The value of a vacuum clipper for clipping herbage for use in yield determinations or to obtain samples for chemical

analysis was investigated. Electronic data processing methods were used for the preparation of a herbarium inventory of taxa in the Oak Ridge, Tennessee, region. An aerial photographic technique using infrared color photographs made with camouflage detection film and taken at a scale of 1:3960 proved efficient for the identification of insect-infested trees and timber types in forests infected with the southern pine beetle (Dendroctonus). Results are reported from measurements of the content of Cs, K, and ^{137}Cs in the flesh of fish collected monthly from the Clinch River and the content of ^{137}Cs, ^{60}Co, and ^{90}Sr in fish and periphyton in White Oak Lake; tracer studies using ^{32}P to determine the standing crop of periphyton and the bottom surface area of a small, rocky stream; the evaluation of methods used for measurements of primary productivity of a green algae (Spongiochloris); measurements of the content of trace elements, with emphasis on Ca and Sr, in plankton off the western coast of Puerto Rico; and the content of Ca, Cd, Co, Cr, Cu, Fe, Mg, Mn, Ni, Pb, and Zn in sediments of the Anasco and Culebrinas Rivers on the western coast of Puerto Rico. Theoretical ecological studies discussed include methods of experimenting with ecosystems, the mathematical modeling of natural populations, ecological compartment models, computer methods for ecological problems, growth models for plants, optimum site problems, and the compartment modeling approach to radioisotope distribution in ecosystems. (C.H.)

8747 (PG-Report-753) THE BIOLOGY OF THE SOLWAY FIRTH IN RELATION TO THE MOVEMENT AND ACCUMULATION OF RADIOACTIVE MATERIALS. XI. GENERAL DISCUSSION. Perkins, E. J.; Williams, B. R. H. (United Kingdom Atomic Energy Authority, Annon (Scotland). Production Group). 1966. 7p. Dep. BIS $0.30. HMSO 1s. 9d.

Radioactive waste solutions from the Windscale works enter the Solway Firth of the Irish Sea. Results are summarized from studies conducted from 1961 through 1964 on the movements of silts and the content of radioactivity in various levels of the food chain, particularly shrimp, salmon, plaice, and flounder. The radioactivity was due to insoluble ^{106}Pu, ^{106}Ru, and ^{90}Sr. The soluble effluent was rapidly mixed and carried slowly out to sea. Measurements of the content of ^{90}Sr and ^{106}Ru in plaice and flounder showed that little of these radionuclides are present in the flesh of the fish where they can be transferred to man. (C.H.)

8748 UPTAKE OF ^{137}Cs BY KATELYSIA MARMORATA. Bhatt, Y. M. (Atomic Energy Establishment, Trombay, India). Curr. Sci. (India), 35: 512-13(Oct. 20, 1966).

Specimens of the clam, Katelysia marmorata, were collected from the intertidal region at Bombay, India, and kept in laboratory aquaria containing carrier-free cesium-137. Clams were removed after immersion periods from 16 to 168 hours and the soft parts dissected out for counting. Samples of the medium were taken at the same time. The samples were counted in a gamma spectrometer. Concentration factors were calculated by dividing the counts per minute per g. of soft parts by c. p. m. per ml. of medium. To study the loss of cesium-137 from animals to water, 18 clams were kept for a day in sea-water containing cesium-137 and then transferred to non-radioactive sea-water. Samples of clams were sacrificed for counting at one-day intervals. The results show that uptake and loss of cesium-137 are rapid during the first day and then become more gradual. The concentration factor for cesium-137 was 10 which was reached after 70 hours. About 77% of the initial activity was lost from the soft parts after 4 days of submergence in non-radioactive sea-water. (H.L.W.)

8749 WATER BUDGET OF A FOREST DAMAGED BY IONIZING RADIATION. Reiners, W. A. (Univ. of Minnesota, Minneapolis); Woodwell, G. M. Ecology, 47: 303-6(Spring 1966).

The changes in water budget induced by exposure of a forest to ionizing radiation were examined in the Gamma Irradiated Forest at Brookhaven National Lab. A central source of γ radiation exposed an oak-pine forest to a gradient of radiation ranging from several thousand R/day within a few meters of the source to levels approaching background at several hundred meters. The source, installed on November 22, 1961, by the following spring had produced mortality of nearly all vascular plants at exposures of more than 350 R/day. Soil-moisture content was measured regularly between June 17 and November 4, 1963, a relatively dry period in which there was little percolation into the water table, so that an estimate of actual evapotranspiration was possible. Cumulative evapotranspiration was only slightly greater in intact zones of the γ-irradiated oak-pine forest than in severely damaged zones. In the central part of this forest where exposures exceeded 160 R/day and only scattered herbaceous plants survived, cumulative evapotranspiration was about 85% that of the intact forest. Rates of evapotranspiration increased along the gradient of decreasing radiation damage during the first half of the growing season, but were roughly equal at all exposures during a drought in the latter half of the season. Differences in rates of evapotranspiration were detectable at chronic exposures of 11.5 R/day, where the dominants retained 50% of their foliage after cumulative exposure of 6300 R over 1½ yr. Thus, a reduction of leaf area of trees alone by 50% had the same effect on evapotranspiration as death of all the higher plants. This relation emphasizes the importance of evaporation from the soil surface as opposed to transpiration in situations where moisture is limiting and energy is non-limiting to the evapotranspiration process. (BBB)

8750 RADIONUCLIDE TRACER STUDY OF ARTHROPOD FOOD CHAINS IN A SPARTINA SALT MARSH ECOSYSTEM. Marples, T. G. (Brookhaven National Lab., Upton, N. Y.). Ecology, 47: 270-7(Spring 1966).

A study was made of passage of radionuclides through the food chain of terrestrial arthropods after labeling grass and detritus in a salt marsh. The marsh grass was principally Spartina alterniflora. The arthropods of the Spartina marsh obtain their energy either by grazing on the marsh grass or by eating the microbial-rich organic detritus that is largely derived from the dead Spartina. The two energy sources were labeled with ^{32}P in separate quadrants and the subsequent buildup of radioactivity followed in the arthropod populations. A sampling program was conducted to obtain arthropods for monitoring the presence of the tracer in the various populations. Four species of insects were dominant grazing organisms (one Orthoptera, two Hemiptera, and one Homoptera) while two families of Diptera (Dolichopodidae and Ephydridae) included the important insects associated with the detritus complex. The spiders were the important carnivores and obtained their energy from both the detritus and grazing food chains. (BBB)

8751 FLY TAGGING: A NEW APPROACH. Hickman, C. (Orange County Health Dept., Anaheim, Calif.); Gates, J.; Edmonds, E. J. Environ. Health, 28: 277-82(Jan.-Feb. 1966).

8752 MUTATIONS IN THE SCREW-WORM FLY. LaChance, Leo E.; Hopkins, D. E. (North Dakota State Univ., Fargo). J. Econ. Entomol., 55: 733-7(Oct. 1962).

There is a need for genetically marked flies that can be reared and released in large numbers in an eradication program in the Southwest using radiosterilized males. In a search to find mutants useful for marker stocks, 377,720 flies have been examined from a large colony submitted to irradiation experiments conducted with ^{60}Co. The flies scanned for mutations came from three sources: (1) Untreated lab reared flies, (2) progeny from irradiated normal parents, and (3) progeny from irradiated flies inbred for two generations. Abnormal flies were considered potential mutants. These individuals were usually crossed with normal flies, and an F_1 generation was reared and examined closely for the appearance of the character. If the character did not appear, the F_1 flies were then inbred. The F_2 generation was examined for the character and discarded if no mutant individuals were found. Nine mutations in Cochliomyia hominivorax were detected. Seven are dominant, five affecting wing characteristics, one affecting body color, and one affecting oral vibrissae. Two are sex-linked recessives, one affecting body color and one affecting wing venation. Pertinent genetic data are presented for each mutant stock. Studies thus far have not produced any mutations associated with a fully recessive autosomal gene or a dominant sex-linked gene. (BBB)

8753 LEVELS AND RATE OF UPTAKE OF ^{137}Cs IN FRESH WATER FISH FROM AN OLIGOTROPHIC LAKE 1962-1964. A FIELD STUDY. Liden, Kurt (Univ. of Lund, Sweden). 4p. (CONF-747-7). ORAU.

From 4th Symposium on Radioactivity in Scandinavia, Riso, Denmark.

Pike of different ages were taken from an oligotrophic (low productivity) lake from 1961 through 1964. The muscle tissue was analyzed for cesium-137 accumulation and the results are shown by a graph. A gradual increase in the accumulation in all age groups occurred until July 1963, and then a rapid increase occurred until September 1964. The cesium-137 content of muscle of four different fish, pike, perch, roach and red-eye, was measured in specimens collected from both oligotrophic (low productivity) and eutrophic (normal productivity) lakes. Results are tabulated. The fish from oligotrophic lake show much higher levels than those from a eutrophic lake. (H.L.W.)

Genetics and Cytogenetics

Refer also to abstracts 8973, 9003, and 9010.

8754 (ORNL-3999, pp 39-53) CYTOLOGY AND GENETICS. (Oak Ridge National Lab., Tenn.).

Progress is reported on the following studies: time of photoreactivation and mutation yield; pyrimidine dimers in Paramecium; intraclonal variations in cell mass and growth rate in Paramecium

aurelia; production of thymine dimers in ultraviolet-irradiated Tetrahymena; changes in soluble carbohydrates of log-phase cultures and synchronized Tetrahymena; recovery from radiation-induced division delay and giantism in Spathidium spathula; action spectra for ultraviolet-induced mutation in Escherichia coli; photoreactivating enzyme in yeast; photoreactivating enzyme in Neurospora; purification of the yeast photoreactivating enzyme; thermal cross section for the reaction $^{33}S(n,p)^{33}P$; photoreactivating enzymes in Drosophila melanogaster extracts; pyrimidine dimers in mammalian cells surviving low doses of ultraviolet radiation; reduction of chromosome breaks by cysteamine in 5-bromodeoxyuridine-substituted mammalian cells; characteristics of radioresistant human amnion cells; amino acid sequences in the α chains of hemoglobins from 3 strains of mice; linkage of Es-1 and Es-2 in the mouse; heterozygosity in chromosomes and in puffs of Sciara ocellaris; changes in chromosomes induced by infection in Sciara; variations in metabolic activity during the larval development of Rhynchosciara; chromosome activity in salivary gland of Rhynchosciara maintained in vitro; isolation of polytene nuclei; changes in the ultrastructure of salivary gland cytoplasm in Sciara ocellaris due to microsporidian infection. (H.L.W.)

8755 (ORNL-3999, pp 54-5) FUNGAL GENETICS. (Oak Ridge National Lab., Tenn.).

Progress is reported on studies on ultraviolet-induced mutants in Neurospora. Emphasis is placed on the revertibility of ad-3B mutants treated with hydroxylamine. The results of these studies make it possible to compare similar data from organisms which differ as markedly as bacteriophage T4 and Neurospora in the organization of their DNA. (H.L.W.)

8756 (ORNL-3999, pp 56-60) DROSOPHILA CYTOLOGY AND GENETICS. (Oak Ridge National Lab., Tenn.).

Progress is reported on the following studies: positive correlation between crossing over in heterozygous pericentric inversions and reduced egg hatch of Drosophila females; evidence on the nature of dosage compensation in Diptera; cytological demonstrations of nonhomologous pairing in the oogonia of Drosophila melanogaster; electrophoretic variants of α-glycerophosphate dehydrogenase and their genetics in Drosophila melanogaster. (H.L.W.)

8757 (ORNL-3999, pp 61-4) CYTOCHEMISTRY AND CELL REPRODUCTION. (Oak Ridge National Lab., Tenn.).

Progress is reported on the following studies: spontaneous mutation rate of the tr_{1-1} mutant and its suppressors in yeast; x radiation sensitivity of Habrobracon oocytes at diakinesis; time of death of a translocation segregant in Habrobracon; spontaneous mutation frequencies in Habrobracon; x radiation induction of mutations in Habrobracon. (H.L.W.)

8758 (ORNL-3999, pp 79-82) RADIATION MICROBIOLOGY AND MICROBIAL GENETICS. (Oak Ridge National Lab., Tenn.).

Progress is reported on the following studies: new examples of unusually radiation sensitive mutants of Escherichia coli; isolation and characterization of x ray resistant, uv-sensitive strains of Escherichia coli; genetics of a radiation-resistant mutant of E. coli K-12; induction of cell division in radiation-induced E. coli filaments; evolution among substrains of E. coli K-12. (H.L.W.)

8759 (ORNL-3999, pp 88-94) MAMMALIAN GENETICS. (Oak Ridge National Lab., Tenn.).

Progress is reported on the following studies: mutation frequency in female mice exposed to high-intensity x irradiation delivered in small fractions; effect of breeding on the reproductive capacity of irradiated female mice; deficiencies in the mouse; search for intrastrain and interstrain rearrangement heterozygosity in the mouse; survival of spermatogonia of the mouse after irradiation in S and G_2 stages of the mitotic cycle. (H.L.W.)

8760 (ORNL-3999, pp 95-8) HUMAN CYTOGENETICS. (Oak Ridge National Lab., Tenn.).

Progress is reported on studies on the relationship of incomplete chromatid aberrations and the cell cycle. Tables are given to show the frequency of the various types and incompleteness of chromatid aberrations at different times of the cell cycle. A table is also given to show the frequency and ratio of the two types of interchange at different times of the cell cycle. Progress is reported on the metric analysis of the human karyotype. To develop methods for the statistical analysis of chromosome arm lengths, a series of cells was selected from one peripheral leukocyte culture of a normal male. A set of photographic enlargements was then made of each of the selected cells. Measurements of the length of each chromatid of each arm of each chromosome in the cell were made. The failure of the confidence regions to overlap for some individual chromosomes suggests that they may be individually identifiable by means of arm length measurements. (H.L.W.)

8761 (ORO-1747-13) THE PROBLEM OF ESTIMATING GENETIC PARAMETERS IN A RADIATED AUTOGAMOUS POPULATION: AN EXPERIMENT WITH PEANUTS (ARACHIS HYPOGAEA L.). Stucker, Robert Evan (North Carolina State Univ., Raleigh). [1966]. Contract AT(40-1)-1747. 102p. Dep. mn. CFSTI $3,00 cy, $0,65 mn.

Thesis.

Some of the problems which arise when genetic components of variance are estimated in a radiated population were disclosed in the study of a cultivated variety (NC2) of peanuts (Arachis hypogaea) following radiation with 20 Kr of gamma rays. A hierarchial analysis of variance of pedigreed progenies in the M_4 and C_4 generation showed residual variance to be significant and confirmed the presence of radiation effects. The proportional increase in genetic variation in the radiated subpopulation, which was selected for phenotypic normality, over that in the control was not as large as that reported in the literature for other radiation experiments. The genetic model was constructed on the premise that the alleles at a polygenic locus have functionally two states, one which has a positive effect on the expression of a character and one which has a negative effect. Radiation was assumed to induce the mutation of plus alleles to minus alleles and minus alleles to plus alleles with approximately equal frequency, although an allele was restricted to only one mutation. A mutated allele was assumed to have the same effect as the equivalent non-mutated allele at a given locus. Thus, the genotypic array at the i^{th} locus was expressed in terms of the original frequency of the plus allele (p_i) and the mutation rate (μ_i). The residual genetic variance in the radiated subpopulation occurred in the M_1 families component of variance. The degree of confounding between the residual variance and the induced variance was affected by the chimeral sampling problem, the gene frequency at those loci which contribute to the residual variance, the number of loci which contribute to residual variance and the total number of loci which contribute to the genetic variance of a character following radiation. The confounding was not important in estimation of the total variance in the radiated population. For quantifying the induced variation separate from the residual variation the confounding must be determined and the two variances separated. To do this will require further research on the problem. (TSS)

8762 STOCHASTIC MODEL OF THE IONIZING RADIATION INDUCED MUTATION CELL. Wang, Pao-han. Sheng Wu Hua Hsueh Yu Sheng Wu Wu Li Hsueh Pao, 5: 442-52(Aug. 1965). (In Chinese).

The role of induced mutations in the lethal effects of ionizing radiation on microorganisms was investigated using a mathematical model of stochastic processes and the assumption that there is a site in every microorganism that is sensitive to radiation. The induced mutation rate at any certain dose was compared with data on cell reproduction and death and the probability distribution, expected value, and variance of the probability distribution were treated statistically. The expected value for the survival of mutant cells in irradiated populations was obtained. (C.H.)

8763 PERSPECTIVES OF DEVELOPING RADIOHYDROBIOLOGY OF FRESH WATERS. Zhadin, V. I. (Zoological Inst., Leningrad). Hydrobiol. Zh., 1: 20-4(1965). (In Russian).

The subject of radiation hydrobiology includes the investigation of radioactive isotopes that reach various water systems as the result of industrial application, and the use of such isotopes as labeled atoms for solving hydrobiological problems. Its goal is to prevent the contamination of water reserves and to develop methods that may be applied to the purification of contaminated waters by biological methods. Problems in the field of the biotic materials cycle in water reservoirs must also be solved. The health-physics aspect of this science is of special importance to protect the population near industrial-scale atomic installations; it includes a study of contaminated benthonic deposits, flowing up the path of radioactive isotopes from plankton, plants and fish to man through the alimentary cycle. Current studies relate to the determination of buildup factors in hydrobiological organisms. Contamination by fallout amounts only to activities of the order of 10^{-12} Ci/l, which is below the level of activity caused by reactor waste effluents. For hydrobiological labeled atom studies ^{14}C and ^{32}P are used most often, although in some cases ^{35}S and ^{45}Ca were found very useful. The potentially stimulating effect of low-activity radiation on the growth plants is receiving increasing attention, together with the examination of radiotoxic effects on certain organisms. (TTT)

8764 CYTOGENETIC INVESTIGATION OF SURVIVORS OF THE ATOMIC BOMBINGS OF HIROSHIMA AND NAGASAKI. Bloom, Arthur D.; Nerlishi, Shotaro; Kamada, Nanao; Iseki, Tetsuya; Keehn, Robert J. (Atomic Bomb Casualty Commission, Hiroshima). Lancet, 2: 672-5(Sept. 24, 1966). (TID-23420).

The nature and extent of residual cytogenetic aberrations were examined in survivors in Hiroshima and Nagasaki who had been exposed to atomic radiations in 1945. The peripheral leukocyte technique was used to examine 94 survivors together with an equal number of controls. All exposed survivors were less than 30 yr of age at the time of the bombing, and all were within 1400 m of the hypocenters. In 33 patients, or 34% of the exposed, exchange-type chromosomal abnormalities were seen in 1–4% of their peripheral leukocyte metaphases. One minute acentric fragment was found in the 94 controls, and no rings, dicentrics, or translocations were seen. No direct relation to dose or clinical symptoms of radiation sickness at the time of exposure could be found, and both sexes were equally affected. All were healthy at time of examination. Both atomic explosions produced mixed γ and neutron radiations. The proportion of each differed, however, with from 30 to 50% of the average exposure doses in Hiroshima being accounted for by neutron radiation. In Nagasaki the neutron dose rarely exceeded 15% of the total estimated air dose. Therefore, the Nagasaki survivors studied were exposed primarily to γ radiation and the Hiroshima survivors to a mixture. Thus, in terms of residual cytogenetic damage in human chromosomes, γ or mixed γ and neutron radiations do not seem to differ significantly. (BBB)

8765 SOME FURTHER OBSERVATIONS ON THE SEX RATIO AMONG INFANTS BORN TO SURVIVORS OF THE ATOMIC BOMBINGS OF HIROSHIMA AND NAGASAKI. **Schull, William J.; Neel, James V.; Hashizume, A. (Univ. of Michigan, Ann Arbor). Amer. J. Human Genet., 18: 328-38(July 1966).**

This report considers 47,624 observations made in Hiroshima and Nagasaki from 1956 to 1962 relevant to the relation between the sex ratio of offspring and parental exposure to atomic radiation and reviews the evidence presently available on this issue. In terms of the total radiation dose represented, these new data increase the observations previously available by about 70%. This report deals with 4 studies on the sex ratio in infants: (1) born to unrelated parents from 1948 to 1953, (2) born to related parents from 1948 to 1953, (3) born to unrelated parents from 1954 to 1955, and (4) born to parents (related and unrelated) from 1956 to 1962. The total births in these 2 cities for which information is available is now 140,542, and in 73,994 instances one or both parents were exposed to the atomic bombings. The suggestion of an effect of exposure on sex ratio in the earlier data is not borne out by the present findings. It is suggested either that a small early effect has disappeared or that the original observation had no biological significance. The authors emphasize the unsatisfactory nature of the sex ratio as a variable. It is influenced by many factors, e.g., maternal age, paternal age, and parity. It is concluded that the Hiroshima-Nagasaki data fail to provide unequivocal evidence for an effect of radiation on the sex ratio, although they are consistent with a small effect in the early post-bomb years which has since disappeared. (BBB)

8766 CHROMOSOMAL ABERRATIONS IN A NATURAL POPULATION OF CHIRONOMUS TENTANS EXPOSED TO CHRONIC LOW-LEVEL RADIATION. **Blaylock, B. G. (Oak Ridge National Lab., Tenn.). Evolution, 19: 421-9(Sept. 1965).**

The existence of chromosomal aberrations in natural populations of the midge C. tentans is reported, as well as the difference in aberrations observed between populations receiving higher than background levels of radiation due to radionuclides in the environment and other populations exposed to background radiation only. In addition, some findings bearing on possible temporal fluctuation in inversion frequencies are cited. The irradiated population of C. tentans is located in White Oak Creek, which drains the radioactive waste disposal operations of the Oak Ridge National Lab. Some low-level radioactivity is present in the Creek as a consequence of the continued release of rare earths, ^{89}Sr, ^{90}Sr, ^{137}Cs, ^{60}Co, and ^{106}Ru. Calculations of the absorbed dose rate made for the Chironomus larvae averaged 230 rad/yr or about 1000 times background. Salivary chromosomes of the larvae were analyzed for chromosomal aberrations. Three paracentric inversions were found at a relatively high frequency (8.7 to 25.3%) in 3 different populations. With one exception, the frequency of these endemic inversions showed no temporal fluctuation or significant difference in frequencies between populations. When samples taken from the White Oak Creek contaminated with low-level radioactive waste were compared with samples from two other populations, the amount of chromosomal polymorphism in the irradiated and nonirradiated populations was the same, with an average of 0.53 and 0.55 aberration per larva respectively. However, 10 aberrations which occurred at a very low frequency (9 were found only one time) were unique to the irradiated population. It was concluded that the occurrence of new aberrations in the White Oak Creek population was increased by the high background radiation level, and that these new aberrations were rapidly eliminated by selection or genetic drift. The frequency of inversion 1Ra decreased from 55.6% in September to 16.1% in December. During this decrease the observed larval types were significantly different from the expected Hardy-Weinberg frequencies. An explanation of the decrease in frequency was based on a model by Levene for genetic equilibrium involving more than one niche. In this explanation the frequency of the homozygotes was controlled by the availability of the different niches. (BBB)

8767 CHROMOSOMES OF IRRADIATED EMBRYOS. **Sato, Hideo (Hiroshima Univ.). Lancet, 2: 551(Sept. 3, 1966).**

Chromosome studies in 2 human embryos after diagnostic irradiation were performed following therapeutic abortions. In the first case, pregnancy was diagnosed as complicated by uterine myoma or ovarian cyst, and an abdominal x ray series and hysterosalpingography were done during the 10th and 11th weeks of gestation. Six days after the last x ray, hysterectomy revealed a uterine fibromyoma with a normal male fetus (105 mm from crown to heel). The fetal radiation dose was about 190 mrad. The karyotype was normal (46) with XY. Neither numerically nor structurally was there an increase of chromosomal aberrations (in more than 100 mitotic figures examined) as compared with nonirradiated embryos. In Case 2, during the 6th week of gestation the physician did not know that she was pregnant and did a barium meal and enema study to investigate the cause of an umbilical mass. Five days after x-ray exposure the uterine contents were curetted, because of concern about the fetal effect. No embryo was found, but chorionic fragments were cultured. The estimated embryonal dose was about 3900 mrad. The karyotype was normal (46) with XX, but 11 dicentrics and more than 20 chromatid or chromosomal deletions were observed in 100 metaphases studied. (BBB)

8768 PARTIAL EXCLUSION OF BACTERIOPHAGE T2 BY T4: AN EARLY FUNCTION OF THE SECOND LINKAGE GROUP. **de Groot, B. (Univ., Leiden). Genetica, 37: 37-51(1966).**

To study the relation between T4 and the phenomenon of partial exclusion, progeny phage with no more than one T4 gene in a T2 genome were isolated by means of marker rescue from uv-irradiated T4 by unirradiated T2 and by selective plating for marker-rescue progeny. Progeny phage with the adsorption properties of T4 were selected by plating on E. coli B/2. The T4 adsorption properties appeared to have no relation to exclusion. If the property of excluding T2 shown by T4 were caused by an early function, a specific inhibition of the synthesis of T2 DNA could be assumed, but if it were caused by a late function, some step in the maturation of T2 would have been affected. Experiments designed to distinguish between these two possibilities showed that exclusion was an early function. Evidence supporting these possibilities was obtained: In crosses of T2 and T4 am 122, a mutant of an early phage enzyme, T2 was virtually eliminated from the progeny; there was no net synthesis of DNA in the mixed complexes of the non-permissive host; furthermore, there was a loss of DNA, not found in the monocomplexes of T4 am 122; that suggested a specific breakdown of T2 DNA; a cross was made between T4 and a partially non-excludable, otherwise T2-like phage strain that did not exclude standard type T2. The gene responsible for exclusion was segregated in an almost normal way and appeared to reside between h^+ and r at the beginning of the T4 map segment. The frequencies with which the genes of T2 were recovered in the progeny of this cross were observed to show polarity, i.e., the frequency of the T2 genes along the segment of the early functions increased gradually from 0.26 for the adsorption properties to 0.44 for the uv sensitivity of T2 and was in corelation with the position of the genes on the map. (BBB)

8769 THE BEHAVIOR OF ABUTILON HYBRIDUM HORT. "ANDENKEN AN BONN" AFTER SINGLE AND FRACTIONATED IRRADIATION. **Poetsch, J. (Paedagogische Hochschule, Potsdam, Ger.). Z. Pflanzenzuecht., 55: 183-200(Apr. 1966). (In German).**

Rooted cuttings of the GWG mesochimera A. hybridum hort. "Andenken an Bonn" were irradiated with x-ray doses of 500, 1000, 2000, and 3000 R and their reactions were compared with those of plants receiving fractionated irradiation. The fractionated irradiation was performed ten times at one-week intervals with partial doses of 500 R. The LD_{50} after a single irradiation was at 3000 R; with fractionated irradiation the plants withstood a total dose of 5000 R. The primary effects of irradiation, which, however, were not permanent, were expressed in deformed leaf blades, light-dark green mosaics on the leaf blades, succulent leaves, and growth stimulation. Furthermore, growth depressions and single and compound leaf bifurcations occurred. During later development, anomalies of histogenesis (perforations and reduplications) led to dissociation or rearrangement of the partners of the chimera. The following types of dissociation or rearrangement products were obtained: (1) Clone WWW (homohistont, white), (2) Clone GGG (homohistont, green), and (3) Clone GWW (monectochimera, white). Two types deviating from the initial form in habit

arose by somatic mutation: (a) The laciniata variant with very narrow leaf lobes and a narrow white margin and (b) the nana variant with small, three-lobed or faintly five-lobed, green leaves. These variants have so far remained constant vegetatively and will be further reproduced clonally. X irradiation, particularly with fractionated doses, is recommended as a suitable method for rearrangement and dissociation of chimeras in plant breeding work. Fractionated doses have advantages over single irradiations. The histogenic alterations they produce on the experimental plants are just as extensive as those induced by high irradiation doses applied singly but the marked growth depression or lethal injuries provoked under these conditions are largely avoided. (BBB)

8770 MEIOTIC CHROMOSOME REARRANGEMENTS INDUCED IN MICE BY IRRADIATION OF SPERMATOGONIAL STAGES. Leonard, A.; Deknudt, Gh. (Centre d'Etude de l'Energie Nucleaire, Mol, Belg.). Can. J. Genet. Cytol., 8: 520-7(Sept. 1966).

Using the air-drying method for meiotic chromosome preparations from mammalian testes, the frequency of chromosome rearrangements induced by irradiation of spermatogonial stages was studied in five strains of mice, 60 days after 400 R, by observation of spermatocytes at diakinesis or first metaphase. The cells were classified according to the type of chromosome rearrangements observed and to the number of chromosomes involved in these associations. The reciprocal translocation involving four chromosomes was the most frequent type seen. No statistical difference was found between the strains in regard to the nature and frequency of the rearrangements. (auth)

8771 EFFECT OF PENICILLIN FEEDING ON THE FREQUENCY OF X-RAY INDUCED MUTATION IN DROSOPHILA. Shiomi, Toshio (National Inst. of Radiological Services, Chiba, Japan). Genetics, 54: 1077-84(Nov. 1966).

Feeding of penicillin to Drosophila larvae prolonged the larval growth period about one day. However, the rate of emergence was higher than in the control. Penicillin exhibited no mutagenic action at the concentration used (20,000 units per ml culture medium). Sex-linked recessive lethal mutation in sperm x rayed during the last three days of development was decreased about 50% when larvae were fed with penicillin, compared to the control raised on normal food. The relation between radiation dose and mutation remained linear in the penicillin-fed series, as in the control. Penicillin was more effective in reducing mutation when fed during the first half of larval stage than during the second half. (auth)

8772 SPONTANEOUS AND RADIATION-INDUCED CHROMOSOME ABERRATIONS IN THE BONE MARROW OF MICE OF VARIOUS AGES. Bocharov, Yu. S.; Savitskii, V. F. Izv. Akad. Nauk Kaz. SSR, Ser. Biol. Nauk, No. 2, 96-9(1965). (In Russian).

Spontaneous and radiation-induced chromosome aberrations in the bone marrow of newborn mice, of mice upon reaching sexual maturity, and of old mice were studied in order to determine the importance of age on the production of cells with chromosome aberrations. The experiment was performed on newborn mice and on mice 2 months old and 10 months old. In view of reports of differing radiation sensitivity in males and females, only males were used in the experiment. A single x ray dose of 100 rad was administered with the RUP-1 machine; the parameters were as follows: voltage—190 kW, current—15 ma, filters—0.5 mm Cu and 0.75 mm Al, focussing distance—64 cm, intensity of dose—19.3 pad/min. The mice were killed 2, 6, 12 and 24 hours following irradiation. Data on chromosome aberrations resulting from the irradiation are shown in a table. A high number of aberrations were in the newborn mice; the percentage dropped in the 2 month old mice and rose in the 10 month old specimens. The curves for radiation-induced aberrations corresponded to those for spontaneous aberrations for mice of various ages. It is concluded that in the ontogenesis of the animals, there is a period of maximum cytogenetic cellular stability which corresponds to the time the animal reaches sexual maturity. (auth)

8773 THE NATURE AND DISTRIBUTION OF THE MUTATIONS INDUCED BY UNIRRADIATED AND IRRADIATED HETEROLOGOUS DEOXYRIBONUCLEIC ACID IN DROSOPHILA MELANOGASTER. Fahmy, O. G.; Fahmy, Myrtle J. (Royal Cancer Hospital, London). Genetics, 54: 1123-38(Nov. 1966).

Data are presented on the activity of x-irradiated calf-thymus DNA on autosomes and X chromosomes of Drosophila larvae. The only mutations appreciably induced by calf-thymus DNA (injected into adult males or fed to larvae) were small chromosome deletions: Minutes, and elimination of Bar from a marked Y chromosome. Very weak activity also occurred as regards point mutations (recessive lethals and visibles) that was equivalent for the X and 2nd chromosome: these gave mutation frequencies in the proportion of their physical lengths (1 : 2). The yield of point mutations was not increased by irradiation (>400,000 R) of DNA prior to its larval feeding. DNA was inactive as regards the induction of X-chromosome breaks, leading to viable fragments or X0 males, and nondisjunction, whether among the sex chromosomes, or the 4th autosomal pair. The proportion of 4th chromosome minutes after the injection of calf-thymus DNA reached 26% of the total induced, which was considerably lower than that occurring with the other tested samples of the heterologous and homologous material (ranging from 85 to 45%). The variation seemed to be a function of the physicochemical state of the polymer, rather than its chemical constitution or biological source. The 2nd chromosome recessive lethals, recovered after the feeding of calf-thymus DNA, were mainly small deletions which were localized in segments rich in heterochromatin, especially around the centromere. Intercrosses between the independently induced mutations, however, did not yield any instances of allelism, indicating that the mutagenic selectivity of DNA did not extend to the genic level. (H.G.D.)

8774 BIOLOGICAL EFFECTS OF SINGLE AND MULTIPLE TREATMENTS WITH ETHYLENIMINE, NITROGEN MUSTARDS, AND GAMMA RAYS ON BARLEY. Nawar, Maher Mohamed. Pullman, Wash., Washington State Univ., 1966. 165p.

Thesis.

The primary objective of the investigation was to study the mechanisms by which mutagens (ethylenimine, monofunctional and polyfunctional aliphatic nitrogen mustards, and gamma rays) induce a variety of biological changes (seedling growth inhibition, chromosome aberrations, chlorophyll deficient mutations, and spike sterility). The experimental organism was the barley seed (caryopsis) (Hordeum vulgare var. Himalaya). This objective was pursued by the following experimental approaches: comparison between the difference in effectiveness of each of the mutagens to induce any of the biological changes; the influence of pH, dry-back, and pre-soak on the degree of biological changes induced; and analyses of the biological interaction resulting from multiple treatments with gamma rays and any of the chemical mutagens. The results showed that the most efficient growth inhibitors were the polyfunctional nitrogen mustards. This may be due to their ability to form cross-links although cross-linking was found not to be a prerequisite for growth inhibition or mutagenic activity. The most efficient mutagen for chromosome aberrations and M_1 spike sterility was gamma rays, probably a result of the high energy delivered resulting in bond breakage. The most efficient mutagens for chlorophyll deficient mutations were ethylenimine and the monofunctional nitrogen mustard, a result of their ability to alkylate DNA bases. The biological changes induced by ethylenimine or monofunctional nitrogen mustard increased with increasing pH, drying-back the seeds following mutagen treatment, or presoaking the seeds at 0°C prior to mutagen treatment at 20°C. (Dissertation Abstr.)

8775 EFFECTS OF FAST NEUTRONS AND ELECTROMAGNETIC WAVES ON VARIATIONS IN MUTATIONS AND PROPERTIES OF VARIOUS AGRICULTURAL PLANTS. Korokhod, E. (Inst. of Plant Selection and Acclimatization, Krakow). 4p. (In Russian). (CONF-641024-7). ORAU.

From Symposium on Use of Radioisotopes, Warsaw.

Mutations induced in tomatoes and radishes by fast neutrons were observed only in the second generation. In the tomatoes (Stonors Exhibition) the plant appearance, shape of the flower racemes, shape and color of the fruit, and number of seed compartments were changed. The amount of fruit produced was increased 100%, with 20 to 25% increase in sugar and vitamin C. Electromagnetic radiation produced kohlrabi mutants that were later producers; rye plants that had long spikes and gave 30 to 50% higher yields; radishes of different shape; and beans that were prolific and had seeds of different color and shape. The kohlrabi and radishes were more like the wild forms, with absence of a thickened stem. The electromagnetic-irradiated plants had less pollen and fewer seeds. In some of the kohlrabi mutants the vegetative period was 30 to 50% longer. Sweet corn (Golden Bantam) that was irradiated was less productive in the first and second generations. It was concluded that electromagnetic, x, γ, α, and β radiations and fast and thermal neutrons produce similar biological, biochemical, biophysical, and genetic changes. The work was done with seeds irradiated with 1.3 to 3.2×10^6 fast neutrons and with plants irradiated at various stages with 30 to 60 MHz. (TTT)

8776 MECHANISM OF MUTATION AND INDUCING FACTORS. Proceedings of a Symposium held in Prague in August 9–11, 1965. Landa, Zdenek (ed.). Prague, Publishing House of the Czechoslovak Academy of Sciences, 1966. 524p. (CONF-650814).

The induction of mutations in plants, Drosophila, mice, and rats by exposure to γ, neutron, uv, and x radiations is discussed in 40 papers. The induction of plant mutations by chemical mutagens is

discussed in 19 papers. The induction of chromosome aberrations in plants, animals, and man by exposure to ionizing radiations and in plants by exposure to chemical mutagens is discussed in 27 papers. The evolution of protein factors and serological methods for revealing the distribution of protein characters, especially in the plant kingdom, are discussed in 8 papers. Results are included from mutation studies on barley, maize, peas, sugar beets, tobacco, tomatoes, and wheat, Drosophila, mice, and rats. Secondary factors that modify the radiosensitivity of seeds of different plant species are discussed. The possible specificity of chemical mutagens, especially ethyl methanesulfonate and diethyl sulfate, and the importance of mutagen specificity in plant breeding are considered. The relative efficiency of ethyleneimine, dimethylsulfate, ethylmethanesulfonate, and hydroxylamine in inducing visible mutations in plants is compared and the induction of mutations in Drosophila by several chemical mutagens is reported. (C.H.)

Health Physics and Safety

Refer also to abstracts 8280, 8452, 8471, 8722, 8732, 8763, 8948, 8994, 9036, 9084, 9640, and 10197.

8777 (AD-629736) FAMILY SHELTER WOOD A-FRAME. Final Technical Report. Dembo, Michael M.; Lamb, Herbert C. (Protective Structures Development Center, Fort Belvoir, Va.). Oct. 8, 1965. 18p. (PSDC-TR-10). CFSTI $1.60 cy, $0.50 mn.

Construction plans, details and bill of materials for a simple dual-purpose wood A-frame type family fallout shelter are presented. Shelter for 10 persons, based on minimum OCD shelter space requirements, is provided. Radiation shielding to provide a protection factor of 100 is provided by earth mounding over the wood frame. Ventilation for the occupied shelter would have to be provided through manual or manual-electric blowers depending on availability of electric power during the occupancy period. (STAR)

8778 (AD-629914) INTEGRATED GUIDANCE FOR SHELTER MANAGEMENT. THE SELECTION AND RECRUITMENT OF SHELTER MANAGERS. Smith, Robert W.; Jeffreys, Frank B. (American Institutes for Research, Pittsburgh, Pa. Inst. for Performance Technology). June 1965. Contract OCD-PS-64-57. 87p. (AIR-D93B-6/65-TR(a-1)). CFSTI $8.60 cy, $0.75 mn.

The development, field-verification, and revision of guidance materials for the selection and recruitment of shelter managers suitable for use by local civil defense personnel was the purpose of the project. The scope of existing guidance was reduced by eliminating both the training guidance and the discussion of the supporting methodology. A sample of ten representative communities was selected to use the guidance to implement a selection and recruitment program. Data collected included: previous selection and recruitment efforts, comments on the materials, effectiveness of selection and recruitment programs implementing the guidance, and information on the community. Although response to the principles was favorable, considerable difficulty was encountered in convincing the local civil defense personnel to use personal contact in selection and recruitment. In those communities where the guidance was applied, the results indicated that the Guide's recommended methods are superior to the more traditional method of general requests for volunteers. Further verification of the guidance was gained from observing a pilot recruitment program conducted by Region, state, and local civil defense workers in a Western city. (auth)

8779 (AD-629928) DETERMINATION OF SHELTER CONFIGURATION FOR VENTILATION. Summary of Final Report. Hill, Edward L.; Caldwell, J. George; Grogan, William K. (Research Triangle Inst., Durham, N. C.). July 9, 1965. Contract OCD-PS-64-56. 9p. (RTI-OU-177). CFSTI $1.10 cy, $0.50 mn.

In Phase 1 of the National Fallout Shelter Survey (NFSS), all buildings in the United States, except single family dwellings, thought to have a protection factor (PF) of 20 or more and space to shelter 50 or more people were surveyed. Based on the results of the Phase 1 survey, contractors subsequently in Phase 2 of the NFSS evaluated designated facilities to determine the feasibility and cost of: (1) increasing shielding to provide a prescribed minimum protection factor; (2) improving habitability to meet minimum specifications; and (3) increasing shelter capacity. Shelters deemed acceptable also were marked with fallout shelter signs in Phase 2. Approximately 73 million shelter spaces had been marked by April, 1965. (auth)

8780 (AD-630605) ENVIRONMENTAL RADIOACTIVE BACKGROUND SURVEY FOR THE AIR FORCE NUCLEAR ENGINEERING TEST FACILITY. Final Report, June 1, 1957–June 30, 1959. Lintz, David O. (Air Force Flight Dynamics Lab., Wright-Patterson AFB, Ohio). Dec. 1965. 62p. (AFFDL-TR-65-185). CFSTI $6.60 cy, $0.75 mn.

The environmental radioactive background survey was an attempt to establish a base line of the normally occurring radioactivity in the fauna and flora of a particular area subsequent to the operation of a reactor which will release additional radioactivity to the environment. The Health Physics Office of the AF NETF collected samples of water, soil, air, sewage, milk, biological life, and vegetation in a 20 mile radius of the AF NETF site and analyzed the samples for α, β, and γ activity. The results of the analyses over the period of the report are given in graphic form to facilitate making comparison of the fluctuations in the normal background. The wide variations were due to bomb testing not only in the United States but throughout the world. The tests especially noticeable are the result of the last half quarter of 1958 when testing was at a peak. Future samples taken from the same areas will be analyzed when the reactor becomes operational. Comparison then can be made to determine any increased activity which may be attributable to the AF Nuclear Reactor operation. (auth)

8781 (AD-631420) VENTILATION TESTS OF FALLOUT SHELTER SPACES IN NEW YORK CITY AND VICINITY. Final Report. Combe, Michael A.; Nelson, David B.; Tomcala, John C. (Panero (Guy B.) Engineers, New York). Feb. 1966. 115p. CFSTI $11.60 cy, $0.75 mn.

Natural and forced ventilation tests were conducted during 1964 at eight shelter sites. Included were: three (summer) tests in high-rise building core areas; two (summer) tests in public school corridors and basements; one (summer) test in a home basement; one (summer) test in a buried community shelter; one (winter) test in a buried private shelter. Using electro-mechanical "Simocs" to simulate shelter occupancy, the resulting physical environment was measured and analyzed. Manual ventilation devices and water-cooled heat exchangers were developed and tested to determine their ability to provide a more tolerable shelter environment. Formulas for predicting shelter ventilation and temperatures are discussed. Methods for improving ventilation rate are suggested. The report concludes that effective temperature (ET) in naturally ventilated above-ground shelters (loading: one person/10 sq. ft.) will not exceed 85F with outside air at N.Y.C. 15% summer design level. In naturally ventilated buried or semi-buried shelters (one person/10 sq. ft.), ET may exceed 85F at same design level. During normal winter weather (Conn.), naturally ventilated underground shelters with efficient heat sinks will have uncomfortably low ET (40F–50F), if loaded with fewer than one person/10 sq. ft. Radiant reflective insulating paper is found to increase ET by 10–15F while preserving the heat sink. (auth)

8782 (AD-631424) AN INVESTIGATION OF MINIMAL EQUIPMENT NEEDS IN PERSONNEL SHELTERS. Final Report. Havers, John A.; Monk, Claire B., Jr.; Koeller, Erich H. (IIT Research Inst., Chicago, Ill.). June 1965. Contract OCD-PS-64-50. 496p. CFSTI $7.95 cy, $2.25 mn.

The investigation of minimal equipment needs for shelters included an examination of the performance requirements for shelter equipment systems, considering these in relation to the attack-induced environmental factors and to the anticipated conditions of shelter occupancy. With these performance requirements once established, suitable equipment systems are then identified. Here a major emphasis is placed upon the minimization of equipment needs, as dictated by the research concept of the austere shelter. Equipment systems are described for three shelter sizes and for four identified climatic regions. Approximate estimates of equipment costs are included. (auth)

8783 (AD-632351) FURTHER STUDIES ON THE DEVELOPMENT OF A NUTRITIONALLY ADEQUATE FALLOUT SHELTER RATION. Final Report, Pt. 1, March 26, 1964–March 31, 1966. Newlin, Harrison E.; Hayes, Gene L. (Midwest Research Inst., Kansas City, Mo.). Contract OCD-PS-64-120. 38p. CFSTI $3.60 cy, $0.50 mn.

Nutritional supplements were developed for consumption with presently available shelter rations. When consumed as directed, these supplements will supply all the nutritional factors recognized by the National Research Council as essential for the maintenance of adults. They will extend the use of shelter rations to shelter occupants who require special feeding, and to the general population, during the post-attack period. The supplements are of two types: unflavored compressed tablets; and dehydrated spreads, flavored so that they will enhance the palatability of ration biscuit, cracker, and wafer. Accelerated storage tests indicate that (a) the tablets have a high expected shelf life, and (b) the flavor of the spreads should be further stabilized. New mint-type and tableted granular starch carbohydrate supplements were developed, which are soft-textured and fully compatible with the mucous membranes of the oral cavity. (auth)

8784 (AD-632560) EFFECTS OF A NUCLEAR ATTACK ON RAIL ACTIVITY CENTERS. Jones, Paul S. (Stanford Re-

search Inst., Menlo Park, Calif.). July 1961. Contract CDM-SR-CO-37. 95p. CFSTI $10.60 cy, $1.00 mn.

The work reported is the result of an analysis of post-nuclear-attack railroad operation in 12 rail activity centers. The analysis has been based upon the transportation of a single commodity—food. The selected nuclear attack involved 375 4-megaton weapons directed against retaliatory bases and industrial and population centers. The determination of post-attack food transportation requirements was based on the number and location of survivors by county, or similar divisions, and the geographical configuration of surviving yards and rail lines. Interstate food shipments were traced from the point where each rail activity center would be entered to points within 5 or 10 miles of survivors. Supply routes were selected by which food deliveries could be economically made to all survivors and empty freight cars removed. Traffic patterns were established together with yard assignments and requirements for rolling stock. The capability of the rail facilities to accommodate additional traffic was also determined. (auth)

8785 (AD-632963) PREPRODUCTION PROTOTYPE PACKAGE VENTILATION KIT, SECOND STRUCTURAL AND HUMAN FACTORS TEST. Final Report. Libovicz, Basil A.; Neveril, Robert R.; Behls, Herman F. (General American Transportation Corp., Niles, Ill. General American Research Div.). Aug. 1965. Contract OCD-PS-64-22. 95p. (GARD-1278-4.2). CFSTI $3.00 cy, $0.75 mn.

A portable ventilation system, designed for fallout shelters, was manually operated continuously for two weeks. The Package Ventilation Kit (PVK) evaluated included a Fan Assembly plus two Drive Modules. A previous test had disclosed some mechanical weaknesses that were subsequently changed. The modified PVK functioned without any failures; therefore, Specification MIL-V-40645, "Package Ventilation Kit, 20-Inch Fan, Modular Drive (Civil Defense)," was issued 16 August 1965. Minor improvements to this specification are recommended. (auth)

8786 (AD-633233) EXPERIMENTAL PROTOTYPE PACKAGE VENTILATION KIT, FIRST STRUCTURAL AND HUMAN FACTORS TEST. Interim Report No. 29, March 29–April 12, 1965. Libovicz, Basil A.; Behls, Herman F. (General American Transportation Corp., Niles, Ill. General American Research Div.). May 1965. Contract OCD-PS-64-201. 71p. (GARD-1278-4.1). CFSTI $3.00 cy, $0.75 mn.

A structural test and human limit evaluation of the shelter Package Ventilation Kit (PVK) showed that the ventilator can be readily operated for periods of at least three hours with 7 minutes rest each half-hour. The PVK can be operated at pedal speeds from 45 to 63 RPM, and the preferred speed was 55 RPM. The optimum power input was found to be 0.10 horsepower per operator, and the maximum tested was 0.15. Most tests were performed at comfortable conditions, 68 to 72°F effective temperature (ET). The maximum ET imposed was 83°F. Further tests are required to establish work/rest cycles when operating the PVK at elevated ET's. (auth)

8787 (AD-635250) THERMAL HARDENING CONSIDERATIONS PERTAINING TO RESIDENTIAL AREAS. Parker, William J. (Naval Radiological Defense Lab., San Francisco, Calif.). July 6, 1966. 56p. (USNRDL-TR-984). CFSTI $3.00 cy, $0.50 mn.

The incendiary effects of thermal radiation from nuclear weapons on residential areas are considered. It is concluded that a hazard does exist and that the most desirable means of protection is to make the exposed materials ignition resistant. This has the benefit of providing fire protection in peace-time as well as in war and has a better chance of public acceptance. While some fireproof fabrics and flame retardant treatments for cotton and other materials are now available, there are drawbacks which hinder their universal acceptance. The development of new and improved methods of treatment depends upon an improved knowledge of the mechanisms of pyrolysis and ignition and a more fundamental understanding of the action of effective retardants. A discussion of some of the features of pyrolysis, and ignition of cellulose and the action of flame retardants that are of importance in the thermal hardening problem is presented. Some experiments which may help to elucidate these processes are suggested. It is recommended that various fire retardant treatments including presently used chemical flame retardants, halogen flame inhibitors, preheating treatments, and exposure to ionizing radiation be evaluated in terms of the protection that they might provide against the thermal radiation from nuclear weapons. (auth)

8788 (AD-635501) SHELTER OCCUPANCY STUDIES AT THE UNIVERSITY OF GEORGIA. Final Report. Hammes, John A. (Georgia Univ., Athens). Dec. 31, 1965. Contract OCD-PS-65-45. 244p. CFSTI $6.00 cy, $1.25 mn.

Results are summarized from two 300-person shelter occupancy tests conducted during 1965. Participants were men, women, and children, aged 1 to 70 years. Data are presented on environmental conditions and the psychological adjustment of the group to shelter conditions. The training program for shelter managers is also discussed. (C.H.)

8789 (AD-642241) DEVELOPMENT OF FIRE RESISTANCE RATINGS FOR SHELTER COMPONENTS. Final Report, May 1965–February 1966. Waterman, Thomas E.; Salzberg, Frederick (IIT Research Inst., Chicago, Ill.). Mar. 1966. Contract N228-(62479)-68580. 75p. (NRDL-TRC-39). CFSTI $3.00 cy, $0.65 mn.

Experiments were performed to evaluate the responses of shelter components to typical fire exposures in order to develop means for predicting these responses from the results of a minimum number of standardized tests. Exposures were provided by an infrared lampbank. Irradiance levels used varied from 0.1 cal cm^{-2} sec^{-1} (representing a low-level, long-duration debris fire exposure) to about 8 cal cm^{-2} sec^{-1} (corresponding to an estimated maximum exposure intensity from a mass fire). Samples included material of both high and low insulating qualities, inert materials, and those exhibiting ablative and dehydration processes. Each sample was approximately 16-in. wide, 24-in. high and 2-in. thick. Chromel-Alumel thermocouples were located near the center of each sample at various distances from the exposed surface. Results indicate that fire resistance of a barrier is considerably affected by the intensity of exposure. For homogeneous combustible materials, this effect can be expressed approximately in terms of the area equivalence method suggested by Ingberg. For homogeneous non-combustible materials, containing free water this method produced errors ranging from 10 to 31 percent. This error is substantially larger for materials containing both free and chemically-combined water. In the case of non-homogeneous materials, the error ranged from 62 to 86 percent. (auth)

8790 (BNWL-316) EVALUATION OF RADIOLOGICAL CONDITIONS IN THE VICINITY OF HANFORD FOR 1965. Soldat, J. K.; Essig, T. H. (eds.) (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Sept. 1966. Contract AT(45-1)-1830. 39p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The evaluation of results obtained from Hanford environmental surveillance program for 1965 indicates that most of the environmental radiation dose received by the majority of persons living in the neighborhood of the Hanford project was due to natural sources and world-wide fallout rather than to Hanford operations. Of the low-level wastes that were released to the environment from the Hanford plants, neutron-induced radionuclides present in reactor cooling water discharged to the Columbia River continued to be the source of greatest potential radiation dose to people in the environs. (C.H.)

8791 (COO-78-142, pp 1-81) RADIATION PHYSICS SECTION. (Western Reserve Univ., Cleveland, Ohio. School of Medicine).

Results are reported from an evaluation of the accuracy and versatility of thin foil calorimeter as a primary standard for electron beam dosimetry. It was demonstrated that the measurement of the temperature rise of a thin Al foil mounted in a vacuum immediately behind a thin window and beam defining slit will establish to better than 2% the electron density in the detected beam. Preliminary results are reported from the evaluation of the response of LiF loaded Teflon discs for electron beam dosimetry in air and in phantoms. Data are included from studies on the effects of dose rate on the reproduction of cultured mouse lymphoblasts exposed to 300 and 500 R doses of x radiation; factors affecting the volume distribution of erythrocytes in glutaraldehyde-fixed cell preparations; osmatic adaptation phenomenon in mammalian cells, with emphasis on factors affecting the contraction phase in cultured mouse lymphoblasts; the development of time lapse cinephotomicrographic techniques for studies of cell division in cultured cells after exposure to various doses of x radiation; and the development of computer programs for analysis of data on radiation effects on cell division. (C.H.)

8792 (MIT-952-3) RADIUM AND MESOTHORIUM POISONING AND DOSIMETRY AND INSTRUMENTATION TECHNIQUES IN APPLIED RADIOACTIVITY. Annual Progress Report. (Massachusetts Inst. of Tech., Cambridge. Dept. of Physics). May 1966. Contract AT(30-1)-952. 484p. Dep. mn. CFSTI $7.84 cy, $2.25 mn.

Separate abstracts have been prepared for five sections of this report. A list is included of eleven publications for the period covered. (H.L.W.)

For abstracts of individual sections see: 8630, 8672, 8793, 8846, and 9293.

8793 (MIT-952-3, pp 318-33) GENERAL RADIOBIOLOGY. (Massachusetts Inst. of Tech., Cambridge. Dept. of Physics).

The following radiobiological studies are reported: cesium-137

measurements on normal human control subjects; intercomparison of cesium-137 measurements on human beings; potassium-40 measurement of a group of normal subjects; in vivo lean body mass measurement using natural potassium-40 activity; potassium-40 measurements on subjects with muscle diseases; radiological health and accident survey. (H.L.W.)

8794 (NYO–3136-3) STATISTICAL ANALYSIS OF ENVIRONMENTAL AND TOTAL BODY GAMMA-RAY SCINTILLATION SPECTRA, Progress Report, October 1, 1965–September 30, 1966. Pasternack, B.; Liuzzi, A.; Berk, H. W. (New York., N. Y. Inst. of Environmental Medicine). Oct. 31, 1966. Contract AT(30-1)-3136. 54p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

I. The use of computer programs (SIMPAN II, PASLI, LIPAS, and PARAN) for the analysis of the γ spectrum of radionuclides in a variety of environmental samples, including vegetation, soil, mud, water, milk, fish, and human tissues, is discussed. A set of reference spectra was prepared for radionuclides found in the samples. The samples were counted for 100 minutes using a scintillation detector coupled to a multichannel analyzer and associated readout apparatus. The resulting count data was punched onto paper tape and transferred to punched cards by means of a tape-to-card converter. The analyses were done on a CDC-6600 computer. Analyses were done with up to eleven radionuclides in the reference set. Good reproducibility was obtained when the same samples were recounted at intervals of one week to two months. II. The use of a computer program (PARANA-GANCOM) for the analysis of data on the γ spectra from 240 ^{137}Cs sources distributed in a human chest phantom using 6 configurations was compared with data analysis using conventional simultaneous equations. The activity measurements were made using scintillation counters with various size crystals in the tilting chair geometry used for whole-body counting or in a geometry surrounding the mediastinal region with detectors placed anterior and posterior to the phantom. The effects of source configuration on pulse-height distribution were measured. The changes that occur when self-absorption and self-scattering occur in a distributed γ source were easily observed from the appearance of the pulse-height data that was plotted as an option to the computer program. The use of different size crystals yielded different shaped spectra for all the configurations used. III. Applications of the computer programs PARANA and PARANA-GANCOM to the analysis of pulse-height distributions arising from the whole-body γ counting of man using a scintillation detector with photomultiplier used in conjunction with a multichannel analyzer and associated readout apparatus and a tilting chair geometry are discussed. A number of studies, involving the determination of whole-body ^{137}Cs, ^{59}Fe uptake in patients with pernicious anemia, ^{60}Co content in workers who inhaled ^{60}Co oxide dust, and the body burdens from ^{214}Bi and ^{228}Ra in radium dial painters are discussed. The results indicated that current statistical techniques and computer programs used for the assay of environmental samples must be appropriately modified if the entire pulse-height spectrum is to be optimally utilized for whole-body counting situations. (C.H.)

8795 (ORNL–4007) HEALTH PHYSICS DIVISION ANNUAL PROGRESS REPORT FOR PERIOD ENDING JULY 31, 1966. (Oak Ridge National Lab., Tenn.). Oct. 1966. Contract W-7405-eng-26. 300p. Dep. mn. CFSTI $7.00 cy, $1.50 mn.

Separate abstracts were prepared for the 6 included sections. (M.O.W.)

For abstracts of individual sections see: 8565, 8746, 8796–8798, and 9295.

8796 (ORNL–4007, pp 171-210) RADIATION DOSIMETRY. Auxier, J. A. (Oak Ridge National Lab., Tenn.).

Progress is reported in the evaluation of γ and neutron doses received by residents of Hiroshima and Nagasaki exposed to the effects of atomic explosions and the effects of various shielding parameters on the radiation doses. The design of a semiconductor absolute neutron dosimeter is described and results of performance tests are reported. A series of equations based on stopping-power theory were developed to predict radiation injuries after exposure of biological systems. A transistorized fast neutron dose integrator was built for use in the presence of severe environmental conditions. Neutron cross sections are presented for the production of γ rays in air by the ^{14}N(n,γ)^{15}N; ^{14}N(n,α)^{11}B; ^{40}Ar(n,γ)^{41}Ar; ^{16}O(n,n')^{16}O; ^{16}O(n,α)^{13}C; or ^{16}O(n,p)^{16}N reactions that show that ^{14}N is the dominant γ producing source in air with most of the γ rays coming from the inelastic scattering of neutrons by ^{14}N and ^{16}O. Work is reported in progress to determine neutron cross sections for elements in tissue for use in calculations of depth dose in tissue-equivalent phantoms. The distribution of ionization during recombination in ionization chambers was used to study ionization induced by γ or neutron sources. Typical values are presented for linear energy transfer of keV per micron in unit density tissue. The possible use of silver-activated metaphosphate glass and a fluoroglass reader for personnel monitoring is discussed. Neutron-energy threshold detector units employing solid-state nuclear tract detectors were improved by replacing the conventional fissile foils with fissile radiators and nuclear track detectors. Results are reported from an intercomparison of nuclear accident dosimetry systems in which 7 groups participated. A Monte Carlo digital computer code simulating various physical experimental situations was used to study depth dose as a function of energy in a man-equivalent phantom composed of H, C, N, and O in the proportions found in soft tissue and depth dose and LET spectra were computed for 10 different monoenergetic neutron beams ranging from 0.025 eV to 2.5 MeV. Neutron depth dose studies were also made in a 30-cm-diameter × 60-cm cylindrical water phantom. The sensitivity of cellulose acetate butyrate for use in solid-state α particle track detection was evaluated. Plastics were irradiated with helium ions and deuterons using the DOSAR low-energy accelerator and the design is described of a deflection chamber for use with a pair of beam deflection plates on the target end of DOSAR during the irradiation. A technique was developed for the correction of readings from the Radsan neutron-dosimetry system taken in radiation fields of unknown spectra. The final endurance testing of the 150-keV positive-ion accelerator (HPRR) was completed and the accelerator was shipped to the Nevada Test Site and the installation is described. Containers for shipping accelerator targets were designed and fabricated. The Health Physics Research Reactor was operated for a total of 271 hr. Minor design modifications to improve reproducibility of burst yield are reported. (C.H.)

8797 (ORNL–4007, pp 211-41) INTERNAL DOSIMETRY. Snyder, W. S. (Oak Ridge National Lab., Tenn.).

The revision of the standard man is suggested to include the information needed for the estimation of radiation dose, whether from external or from internal sources, to provide an estimate of the variability of dose due to individual differences, and to afford methods of adjusting the estimate to correct for an individual's characteristics. Data are presented on the mass (in g or ml) and the percent of total body of 52 tissues and organs based on a 70 kg man. The revision of the lung model used by ICRP to estimate exposure to an aerosol and to determine maximum permissible concentrations (MPC) for various aerosols is reported. The use of the model in studies on the deposition and clearance of particulate matter from the respiratory tract is discussed and methods and formula for obtaining dose estimates of radioactive aerosols are presented. Phantoms of infants and adults were used to determine variations in the radiation dose (β + γ) from a given unit source of ^{137}Cs in the body of man as a function of body size and position of the source in the body. A three-compartment model for iodine metabolism by the thyroid and by the body is presented that is valid radioactive iodine. The use of the mathematical equations was demonstrated by employing ^{131}I as an example. Computer studies are discussed on the linear combination of exponentials representing power functions used to represent data on excretion from and retention in the body of bone-seeking radionuclides. Data are presented on the elemental composition of standard man. The percent by weight and amount in grams of 38 elements in a 70-kg man are given. Diets of teen-age children in several cities of the United States were analyzed for Cs and Rb content. Procedures used for chemical preconcentration plus flame photometry are discussed and results are included from an analysis of ashed biological materials for inorganic elements. (C.H.)

8798 (ORNL–4007, pp 243-67) HEALTH PHYSICS TECHNOLOGY. Fish, B. R. (Oak Ridge National Lab., Tenn.).

Mechanisms for the adhesion of solid particles to surfaces are reviewed with emphasis on capillary and electrostatic forces that may affect the accidental resuspension of radioactive particles from surfaces in the working environment. Data are included from a study of electrical forces in the adhesion of particles. The existence and magnitude of electrical fields related to charged surfaces were determined in two hot-cell facilities. Problems involved in the determination of maximum permissible concentrations (MPC) for radionuclides deposited on surfaces are discussed. A study was initiated to determine the degree of initial retention of particles falling vertically in a uniform fallout field on the skin. Preliminary results indicated that initial deposition is proportional to particle size and skin surface moisture and that retention time has an inverse relationship to particle diameter but is also affected by capillary forces acting between particles and the surface layer of skin oils and moisture or by being trapped by hairs, which may cause great variation among individuals. A series of tests were carried out to determine the effectiveness of simple countermeasures in removing small spherical particles from the skin in which it was shown that brushing with the hand and finger followed by rinsing under running tap water and subsequent washing with

soap and water gave good decontamination results. Preliminary results of spectrum and radiation dose measurements from discrete β-emitting sources in contact with or implanted in the skin are reported and methods are described. Methods for the dosimetry of small intense β-emitting particles deposited on the skin or in the gastrointestinal tract of man are discussed and techniques using extrapolation dosimetry using an anthracene scintillation detector and computer analysis of data and ionization extrapolation chamber are compared. Applications of the ORNL in vivo γ spectrometry facility in the routine monitoring of employees and evaluation of exposure to γ-emitting radioisotopes or to determine the location of a contaminant or the amount of activity in a particular organ or body part are discussed. A total of 593 counts were made on 463 persons from July 1, 1965 through May 31, 1966. Approximately 89% of the persons counted showed a normal human spectrum. Data are summarized on the 11% with measurable amounts of internal radioactivity other than normal ^{40}K and ^{137}Cs. A computer program was written for the analysis of whole-body γ counting data. Methods for correcting ^{239}Pu wound counts for attenuation in tissues and for the ratio of ^{241}Am to ^{239}Pu were investigated. Methods are described that were used to measure the absorption of ^{90}Sr from a puncture wound of the finger made by a stainless steel wire contaminated with ^{90}Sr + ^{90}Y. The absorption of ^{90}Sr into the body was studied by analysis of blood and urine and residual ^{90}Y in the finger was determined by counting β activity with an end-window GM beta counter. Methods of sample preparation for the determination of ^{85}Sr and ^{90}Sr in urine are discussed. (C.H.)

8799 (ORNL-TM-1569) RECENT ADVANCES IN MONITORING OF RADIOACTIVE GASEOUS WASTES AT ORNL. Manneschmidt, J. F. (Oak Ridge National Lab., Tenn.). Oct. 13, 1966. Contract W-7405-eng-26. 37p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Many activities at the Oak Ridge National Laboratory are concerned with the chemical processing of radioactive materials. Gaseous effluents from these operations are treated to remove dangerous contaminants prior to release to the atmosphere. Routine monitoring of such emissions was started in 1956 when manually operated particulate monitors were installed at each of three process stacks. Since that date, coverage has been extended to six stacks, the sample withdrawal system has been rebuilt, and the detection equipment has been added to and modernized. The intensive monitoring has lead to process improvements which have reduced the environmental releases of radioactivity in the Laboratory's gaseous waste effluents by a factor of three since 1962. (auth)

8800 (PG-Report-734) TISSUE DOSE-EQUIVALENT RATES. I. FROM COSMIC RAY NEUTRONS. II. IN THE LOW LEVEL ENVIRONMENT OF CHAPELCROSS NUCLEAR POWER STATION. Watt, D. E.; Clare, D. M.; Gordon, A. R. B. (United Kingdom Atomic Energy Authority, Annon (Scotland). Production Group). 1966. 12p. BIS $0.50, HMSO 2s. 6d.

On the basis of published data from cosmic ray studies, the dose-equivalent rate due to naturally occurring neutron radiation is calculated to be 11.8 ± 1.0 mrem/yr for a small piece of tissue in air at sea level and at a location with geographical coordinates (lat. 55°2'N, long 3°21'W). It is deduced that the neutron dose equivalent experienced by the population at sea level for isotropic irradiation varies from 6.2 ± 0.5 mrem/yr at the surface of the body to 56% of this value at 10 cm deep assuming the body is represented by a semi-infinite slab of tissue 20 cm thick. The dose-equivalent rate at the surface of the body for persons flying at supersonic transport altitudes (65,000 ft) is 0.20 ± 0.02 mrem/hour. Experimental measurements, using the spherical moderator technique, confirm the calculated value for the natural dose-equivalent rate. These measurements were extended to determine contours of dose-equivalence in the low level environment of the reactor installation. It is found that the natural level is not exceeded outside the perimeter fence and that the normal working locations of all employees within the establishment are subjected to neutron dose-equivalent rates well below the maximum permissible recommended by I. C. R. P. In most cases the levels are about five times natural background. (auth)

8801 (RFP-795) DATA USED IN HEALTH PHYSICS CONSIDERATIONS FOR PLUTONIUM AND AMERICIUM. Putzier, E. A. (Dow Chemical Co., Golden, Colo. Rocky Flats Div.). Nov. 23, 1966. Contract AT(29-1)-1106. 40p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Data used in health physics considerations of Pu and Am are summarized. The nuclear constants of ^{238}Pu, ^{239}Pu, ^{240}Pu, ^{241}Pu, ^{242}Pu, ^{241}Am, and ^{237}U are presented. Data are included on the γ dose rates from semi-infinite thick pure metal slabs of ^{238}Pu, ^{239}Pu, ^{240}Pu, ^{241}Pu plus the daughters ^{241}Am and ^{237}U, surface dose rates from x and γ rays from ^{241}Am growth, surface dose rates from γ rays from ^{237}U growth; the effects of the decay of ^{241}Pu to ^{241}Am and ^{237}U on the x and γ activity of a mixture of Pu isotopes; neutron radiation values (ngs) for ^{238}Pu, ^{239}Pu, ^{240}Pu, and ^{242}Pu; methods used to express the growth of ^{241}Am from ^{241}Pu; the amounts and energies of fission product impurities (^{103}Ru–^{103}Rh and ^{95}Zr–^{95}Nb) associated with Pu operations; the γ shielding properties of various materials, including Pb glass, Pb gloves, safety glass, plexiglass, Pb, and steel; data useful for calculating the isotopic abundance and radiation dose from Pu during shipment; data used in monitoring work areas for α and β activity associated with Pu isotopes; and data used to calculate the body burden from inhaled particles of Pu or Pu-contaminated wounds. (C.H.)

8802 (RFP-799) RESTRICTED RELEASE OF PLUTONIUM. Hunt, D. C. (Dow Chemical Co., Golden, Colo. Rocky Flats Div.). Oct. 17, 1966. Contract AT(29-1)-1106. 69p. Dep. mn. CFSTI $3.00 cy, $0.75 mn.

A study was made of the possible hazard outside an enclosure due to the uncontrolled oxidation of plutonium within the enclosure. Data on the existent observational restricted plutonium release are reviewed and a release model was constructed relating the free release source strength and the parameters describing the release. The method of analysis is to postulate a set of accidents in which the release variables are individually maximized. The accident that the model indicates as having the greatest release potential is taken as the maximum credible accident. The method is used to evaluate the leakage limits of the critical mass assembly cell of the Rocky Flats Plant Nuclear Safety Facility. The results generally indicate that restricted release is unlikely to lead to dangerous air-borne plutonium concentrations and specifically show the Rocky Flats Plant Assembly Cell leakage limits are conservative by several orders of magnitude. (auth)

8803 (RFP-810) ROCKY FLATS RESPIRATOR-FITTING PROGRAM. Hammond, S. E.; Hill, J. E. (Dow Chemical Co., Golden, Colo. Rocky Flats Div.). Nov. 28, 1966. Contract AT(29-1)-1106. 5p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The experience is reviewed of fitting, in the field, over 2000 workers with several different types of half-mask respirators used for protection from toxic materials. Procedures, numbers receiving a satisfactory fit, and areas of possible respirator improvement are discussed. (auth)

8804 (STI-PUB-102) INTERNATIONAL CONVENTIONS ON CIVIL LIABILITY FOR NUCLEAR DAMAGE. Legal Series No. 4. (International Atomic Energy Agency, Vienna (Austria)). May 1966. 252p. IAEA: $5.00; S 105,-; £ 1.10.0; F Fr 20,-; DM 17,50.

Civil liability for nuclear damage that might occur in the course of the operation of a nuclear installation or a nuclear ship, or during transport of nuclear material is considered, including the four multilateral conventions on the subject that so far have been concluded. The texts of the International Conventions on Civil Liability for Nuclear Damage and the ancillary instruments thereto are presented in English, French, Russian, and Spanish. (H.G.D.)

8805 (AEC-tr-6634) RADIOACTIVE FALLOUT. PHYSICS, BIOLOGICAL EFFECTS AND PROTECTIVE MEASURES. Petrov, R. V.; Pravetskii, V. N.; Stepanov, Yu. S.; Shal'nov, M. I. Translation of Zashchita ot Radioaktivnykh Osadkov, Gosudarstvennoe Izdatel'stvo, Meditsinskoi Literatury, Moscow, 1963. 140p. (IPST-Cat.-1508). Dep. mn. CFSTI $5.00 cy, $1.00 mn.

An abstract of this monograph was prepared on the original Russian-language publication and appeared in NSA Vol. 18 as number 8567. (C.H.)

8806 (AEC-tr-6641, pp 78-104) CERTAIN BIOLOGICAL ASPECTS OF RADIOACTIVE CONTAMINATION OF THE SEA AND OCEANS. Polikarpov, G. G. Translated from Radioaktivnaya Zagryaznennost' Morei i Okeanov, Izdatel'stvo Nauka, Moscow, 1964.

Methods for expressing the radioisotope concentrating ability of marine hydrobionts and dependency of such expressions on factors in the medium are reviewed. Accumulations of ^{90}Sr, ^{137}Cs, ^{91}Y, ^{144}Ce, ^{60}Co, ^{65}Zn, and ^{106}Ru in hydrobionts were determined. Accumulation coefficients showed that yttrium and cerium were generally distinguished by the largest accumulation coefficients; germanium and phosphorus, average; strontium and cesium, small; and sulfur the least. Fate of accumulated radionuclides after death of the organism, transfer of radioisotopes through seafood resources to man, and effects of radioisotope emissions on physiology of hydrobionts are discussed. (H.G.D.)

8807 (AEC-tr-6641, pp 105-14) RADIOACTIVITY OF CERTAIN MARINE LIFE OF THE FAR EASTERN SEAS IN 1958 FOLLOWING NUCLEAR WEAPONS TESTING BY THE USA IN THE CENTRAL PART OF THE PACIFIC OCEAN. Moiseev, P. A.; Kardashev, A. V. Translated from Radioaktivnaya Zagryaznennost' Morei i Okeanov, Izdatel'stvo Nauka, Moscow, 1964.

Surveys were made in 1958 of the radioactive contamination of marine organisms. Results show that: plankton, the basic food for fish, and laminaria from the Far East were contaminated as a result of nuclear weapons tests in 1958; the magnitude of radioactive contamination depended on the sites of habitation; and water masses carry radioactivity for great distances. (H.G.D.)

8808 (AEC-tr-6641, pp 115-20) BIOLOGICAL INDICATION OF WEAK RADIOACTIVE CONTAMINATION OF SEA WATER. Fedorov, A. F. Translated from Radioaktivnaya Zagryaznennost' Morei i Okeanov, Izdatel'stvo Nauka, Moscow, 1964.

A method is presented for determining radioactivity of sea water by finding the radioactivity in a planktonic sample taken from a known volume of water. It was decided that the Copopod Calanus finmarchicus was an effective biological indicator for northern seas. Experimental verification with various isotopes showed that with Calanus a contamination within the limits of 4.0×10^{-8} to 4.0×10^{-7} Ci/l may be detected. Preliminary investigations on the development of a method for the biological indication of radioactive contamination of the North Cape current showed that it is possible to use the large krill Meganyctiphanes norvegica. (H.G.D.)

8809 (AEC-tr-6641, pp 121-7) RADIOACTIVE CONTAMINATION OF ORGANISMS OF THE BLACK SEA, RESULTS AND PROCEDURE FOR DETERMINING ^{90}Sr IN THE CYSTOSEIRA. Vende, G. V.; Parchevskii, V. E. Translated from Radioaktivnaya Zagryaznennost' Morei i Okeanov, Izdatel'stvo Nauka, Moscow, 1964.

The ^{90}Sr content in marine organisms under natural conditions was studied by extractive chemistry and scintillation radiometry. Data on the concentration of radiostrontium in Cystoseira barbata ash ($2.55 \cdot 10^{-13}$ Ci/g) agrees with data published on the content of ^{90}Sr in Sargassum enerve. Among the various marine organisms studied the greatest amount (1.10^{-14} Ci/g) of radiostrontium was detected in the hydrocoral Stylaster sp. (H.G.D.)

8810 (AEC-tr-6641, pp 128-44) THE RADIOACTIVITY OF CERTAIN ORGANISMS OF THE BLACK SEA. Parchevskii, V. P. Translated from Radioaktivnaya Zagryaznennost' Morei i Okeanov, Izdatel'stvo Nauka, Moscow, 1964.

Fourteen marine species were analyzed radiometrically in search of an indicator for artificial radioactivity. The increase of artificial radioactivity was evidenced by an increase in the radioactivity in Cystoseira between 1939 and 1959. Geographic distribution of artificial radioactivity in Cystoseira specimens indicated similar levels of contamination in the Adriatic and Black Seas in 1959. Data on the brown alga Cystoseira were verified with the red alga Laurencia. Application of absorption curves, qualitative radiochemical analysis, and data from beta and gamma spectroscopy suggested that artificial radioactivity with energies greater than 1.4 MeV may be attributed mainly to ^{144}Ce–^{144}Pr. (H.G.D.)

8811 (AEC-tr-6641, pp 145-56) APPLICATION OF DEEP-WATER γ-RADIOMETER FOR RADIOACTIVITY MEASUREMENTS IN THE OCEAN. Khitrov, L. M.; Koklyarov, K. A. Translated from Radioaktivnaya Zagryaznennost' Morei i Okeanov, Izdatel'stvo Nauka, Moscow, 1964.

An automatic gamma radiometer was designed for radioactivity measurement at maximum depths in the ocean. Using the radiometer with a sensitivity threshold of 2×10^{-10} Ci, radioactivity levels exceeding background by a factor of more than 2 or 3 were not detected in the central and northern parts of the Indian Ocean during 1960. (H.G.D.)

8812 (AERE-Trans-1064) EXPLOSIONS CAUSED BY LIQUID OXYGEN. Weber, U. Translated by R. A. Slingo (Atomic Energy Research Establishment, Harwell, Eng.), from Chim. Ind. (Paris), 90: 178-83(1963). 10p. Dep. mn. BIS $0.50, HMSO 2s. 6d.

Details are given of some serious explosions that have occurred in industries using liquid oxygen, and special safety measures that are being adopted. Among recommendations made are the following: floors where the transfer of liquid oxygen is carried out should be of non-flammable material, such as concrete; transfer pumps must be free from all trace of moulding sand and oil, to avoid seizing, heating and ignition; and in installations for fractional distillation of liquid air all parts should be of non-flammable material. (UK)

8813 ATTEMPT TO STUDY THE CONTAMINATION OF LIVESTOCK BY ^{131}I UNDER NATURAL CONDITIONS. Michon, G.; Jeanmaire, L. (Centre d'Etudes Nucleaires, Fontenay aux Roses, France). Bull. Acad. Vet. France, 36: 311-15(July 1963). (In French).

Considerable contamination of milk by ^{131}I was found in the autumn of 1961 as a result of atmospheric nuclear detonations. A study was made of ^{131}I in cows and their calves under field conditions. The ^{131}I level in forage reached a peak in early December which was followed by a peak, later in December, in the ^{131}I content of milk. Thereafter the levels in forage and milk fell rapidly, mainly because of the relatively short half-life period of ^{131}I. The amount of radioiodine in the milk corresponded to about 1% of the amount in the daily diet. This contrasts to a figure of ~3% found under experimental conditions. The time for equilibrium between ^{131}I in the forage and in the milk of cows is about 15 days. Radioiodine content in the thyroid was determined in cows slaughtered at different dates. It rose from a level of $\sim 2 \times 10^{-5}$ μC on December 1 to a max of 62×10^{-5} μC on December 21, 1961. (BBB)

8814 LUNG CORRECTION IN FIXED-FIELD MEGAVOLTAGE THERAPY. Woodger, E. G. (Royal Adelaide Hospital). Radiol. Technol., 37: 264-8(Mar. 1966).

Methods are described for measurement of dose distribution in the lungs during radiotherapy. Tumors within the thorax require that the standard depth dose data be modified, because the density of lung tissue in its aerated form is ~0.3 g/cm^3. This marked reduction in density has been shown to have considerable effect on the rate of absorption of the primary beam and the scattered radiation therein. The magnitude of change between the treatment planned was found to be 20 or 30% more if the aerated tissue effect was ignored. This is far beyond that which is clinically acceptable. It was found necessary to estimate first the total amount of air on the central axis of each oblique field by transmission measurements. A certain percentage of an x or gamma ray beam was transmitted through a specific amount of absorbing material. A cobalt-60 unit that has been modified for transit dose measurement was used. Percentage transmission of the cobalt-60 beam was measured through the central axes of the oblique fields and from the percentage transmission in water; from this, the total effective thickness of the axes, in terms of unit density material in respect to transit dose measurements, were obtained. Tumor-air ratios, being a function of absorbing material only, were applied in such a way as to indicate the relative change in doses that occurred due to the presence of air; standard percentage depth-dose data were then modified accordingly. Opposed fields with equal incident doses were found to provide the most suitable method, as it eliminated errors that may be associated with the estimation of relative lung distribution. (BBB)

8815 RECENT STUDIES IN NUCLEAR POWER PLANT SAFETY. I. STUDY ON REMOVAL OF IODINE FROM ATMOSPHERE BY SPRAY. Nishiz[illegible]a, Yukinori; Maekawa, Tatsuo; Kawaguchi, Osamu; Oshima, Shigeo (Mitsubishi Atomic Power Industry, Inc., Omiya, Japan). Nippon Genshiryoku Gakkaishi, 8: 598-602(Nov. 1966). (In Japanese).

The results of experiments simulating the iodine washout effect provided by a container spray in an accident are reported. A stainless steel drum 1.5 m diameter and 3 m high was used as a small scale model of the container. The removal rate of iodine from an atmosphere of pressurized steam of 100 to 150°C (saturated steam pressure) by spray (spray water temperature: 25°C, rate: 25 to 200 l/hr) was determined from an analysis of iodine in the gas phase. The result indicated that iodine in the atmosphere was removed by the spray at a rate proportional to the spray rate, and the removal rate increased with decreasing initial iodine concentration in the drum. (auth)

8816 ^{90}Sr CONTENT OF DECIDUOUS HUMAN TEETH. Santholzer, W.; Knaifl, J. (Charles Univ., Hradec Kralove, Czechoslovakia). Nature, 212: 820(Nov. 19, 1966).

Teeth extracted from two groups of children, aged between 3 and 6, and between 6 and 10 years, were analyzed for ^{90}Sr. Teeth of adults over 20 yrs old were used as controls. The 3 to 6 yr group contained 2.9 pCi/g of calcium, the 6 to 10 yr group 2.5 pCi/g of calcium, and the adult group 1.4 pCi/g of calcium. These values are of the same order as those for the content of ^{90}Sr in bone. It is suggested that the radioactive content of teeth can be used as an index of accumulation of radionuclides in children. (H.L.W.)

8817 RADIOACTIVE CONTAMINATION OF FALLOUT IN FOODS. III. CONTAMINATION FROM ^{90}Sr AND ^{137}Cs IN FOODS SAMPLED IN THE CITY OF NOVARA. Molinari, G.; Romagnoli, G. (Centro per la Rivelazione della Contaminazione Radioattiva, Pavia, Italy). Riv. Ital. Ig., 25: 3-9(Jan.-Apr. 1965). (In Italian).

The ^{90}Sr and ^{137}Cs concentrations were determined in 42 samples of foods obtained from retail markets of Novara. The maximum ^{90}Sr level in milk was 42.2 pC/l; the highest values were observed in some cheese and wheat grain samples. Eight samples of bread and pasta were also examined. Average concentration of ingested ^{90}Sr per person per yr was calculated for the various foods. Numerous tables of data are provided. (BBB)

8818 NON-OBSTETRIC DIAGNOSTIC RADIOLOGY DURING PREGNANCY. Harris, G. B. Clifton (Boston Lying-In Hospital). Clin. Obstet. Gynecol., 9: 59-70(Mar. 1966).

Risks encountered from the diagnostic use of x rays in preg-

nancy are assessed, and precautions to be followed to reduce fetal hazards are explained. Whether the amount of radiation encountered in diagnostic radiology constitutes a definite hazard is not yet known with certainty. Mothers of children with leukemia are reported to show an increased incidence of radiographic examinations of the abdomen during pregnancy, but other prenatal events also had occurred significantly more often than among the controls, such as virus infection and threatened abortion. Although fetal radiation may not account for an increased incidence of childhood malignancies, the need for minium dose radiography should be stressed. Although radiologic evaluation may often safely be delayed until after delivery, undue concern about the postulated harm of diagnostic radiation should not deter its use when it is likely to provide information essential to the immediate care of the patient, particularly if such information can be obtained in no other practical way. In doubtful cases when x-ray studies are proposed, the radiologist can plan the study so that it will expose the patient and fetus to the least amount of radiation. The chest is the area most frequently studied roentgenographically in the pregnant patient. With the use of a well-collimated x-ray beam and light localizers or with direct shielding of the maternal abdomen, the fetus will receive only negligible scatter radiation. However, with photofluorographic apparatus and miniature films for such routine chest studies the dose is appreciably higher, and with poor coning the fetus may be included in the direct beam. Precautions to be used in each type of x-ray examination are outlined. (BBB)

8819 A METHOD OF SKIN DOSE CALCULATION FOR ARC THERAPY WITH MEDIUM ENERGY X-RAY AND RI γ-RAY. III. ON THE EFFECTIVE BACKSCATTER FACTOR EB, CORRECTION FACTOR K AND RELIABILITY OF THE CALCULATED SKIN DOSE. Yamazaki, Takeshi; Hayami, Akimune (Osaka Univ.). Nippon Acta Radiol., 25: 200-4(June 1965). (In Japanese).

Comparative studies were made on the reliability of reported methods for the calculation of radiation dose to the skin during arc therapy with medium energy x radiation or γ beams. The influence of the field size and the design of the collimating system on the skin dose are discussed. Numerical values for air dose, backscatter, and correction factors were calculated for use in routine clinical dosimetry. (C.H.)

8820 PERMISSIBLE LEVELS OF RADIATION. Brit. Med. J., 1: 1374(June 4, 1966).

The eventual radiation dose incurred by the population of the United Kingdom from nuclear weapon tests carried out up to the end of 1965 will be much less than the dose delivered by the natural background of cosmic rays and terrestrial radioactivity. The number of cases of leukemia and other malignant diseases attributable to fallout from these tests should not exceed five per million of population and may be much less. The incidence of visible genetic abnormality in the next generation may be about one case per million of exposed population. Countermeasures against fallout are not practicable on a large scale. The United Kingdom Medical Research Council recommends that no attempt should be made to establish, in advance, cautionary levels at which action must be taken to deal with dietary or bodily contamination by radioactive fallout. This advice is consistent with the recent findings of the International Commission on Radiological Protection, but represents a change in the policy which the Council has followed since 1956. The Council now accepts the view of the International Commission that maximum permissible levels of exposure to radiation should be prescribed only for activities where the exposure is controllable, for example, in industry and clinical practice. For accidental exposure (including fallout), the remedial measures should be judged according to prevailing circumstances, the social cost of changes in habit of life or diet being weighed against the expected mitigation of the consequences of exposure already incurred. In the present state of knowledge it is not possible to give an exact numerical definition of overexposure to radiation, or, in most cases, to provide any effective treatment. (BBB)

8821 CANCER THERAPY: COMPUTATION AND VISUALIZATION OF DOSE DISTRIBUTION IN EXTERNAL BEAM THERAPY. Sterling, T.; Perry, H. (Univ. of Cincinnati). J. Chron. Dis., 19: 523-39(Apr. 1966).

Development of general field equations that allow calculation of percentage depth doses resulting from external sources of ionizing radiation have made possible the computation of many points in the treatment volume and the visualization of the dose distribution through on-line printing or graphing devices. This, in turn, has led therapists to study the best conditions for treatment and seek improved methods by which the shape and pattern of the treated body volume may be manipulated. The results permit a decrease in undesirable treatment side-effects and there is presumptive proof that optimization of planning will result in increased survival. Two approaches by which a computer may accomplish a graphic output and new methods of visualization of computer outputs are described. (C.H.)

8822 CURRENT THINKING ABOUT RADIATION DANGERS. Stoneman, D. W. (Univ. of Toronto). J. Can. Dent. Ass., 32: 334-40(June 1966).

Ways in which dentists can protect their patients and other persons from unnecessary x-ray exposure are presented. Measures for the protection of the patient discussed include collimation of the primary beam to a dia of 2.75 in. at a distance of 8 in. from the focal spot, placement of sheet aluminum between the beam source and the patient to filter off useless soft rays, use of an open-end shielded cone in place of the traditional plastic director cone, employment of lead aprons, a min no. of film exposures consistent with diagnostic requirements, observance of good radiographic technique, and periodic examination of x-ray equipment to detect any radiation leakage. The operator should avoid the primary beam and should maintain an average distance of 6 ft from the patient's head. Suitable barriers on the floor, ceiling, and walls may be required to shield other persons within or beyond the confines of a dental practice. Whereas somatic exposure was formerly considered significant, radiation received by the reproductive organs is now regarded as of major importance. Nevertheless, persons such as dentists who are occupationally exposed to radiation may be allowed a slightly higher exposure without affecting the mutation rate of the population as a whole and without immediate or delayed somatic injury. Also discussed are doses received by patients in various dental radiographic procedures, methods of detecting excessive exposure, and the contribution of fallout to the human somatic and genetic burden. (BBB)

8823 100-Curie ^{137}Cs UNIT: PHYSICAL ASPECTS. Lakshmanan, A. V.; Paul, K.; Vanithamony, V. (Cancer Inst., Madras). Indian J. Cancer, 2: 110-14(June 1965).

Construction and operating characteristics of the ^{137}Cs source are described. Clinical experience showed that skin reactions were almost negligible as compared to those of 250-kv x rays. Radiation protection measurements were carried out using an ionization chamber type of survey meter. With the beam off, the dose rates on the surface of the head were seen to vary from 3 to 30 mR/hr; less than 2 mR/hr at one m from the source. With the beam turned on dose rates were determined at various sites in the treatment room. Outside the 12-in. thick concrete which shields the room where the unit is installed, the dose rates were far below permissible level. Half value layer measurements were made using a narrow collimated beam of radiation, and the values obtained are listed. Central axis depth dose values for various field sizes were measured with an ionization chamber on tissue equivalent rubber (density 1.01). Percentage depth dose curves for some of the field sizes used are presented in table form. A film method was used to obtain isodose curves. In units utilizing short source-to-skin distances for treatment, the inverse square law was found to be more important than the energy of the beam in determining depth doses in Compton absorber-like human tissue. Hence, ^{137}Cs was found to be as good a source as ^{60}Co for such units. The 33-yr half life of ^{137}Cs as compared to that of 5.2 for ^{60}Co, and the smaller amount of room and sourcehead shielding required (owing to the lesser energy of the beam 0.66 MeV for ^{137}Cs vs 1.25 MeV of ^{60}Co) were noted as definite advantages from the point of manufacturing cost. Also, the hard radiation of ^{137}Cs avoids preferential absorption in surrounding bone and offers a definite advantage in the treatment of lesions of the head and neck. (BBB)

8824 PROTECTION IN THE ENVIRONMENT OF RADIOLOGIC WORKERS. Oliva, Luigi (Univ., Siena, Italy). pp 171-9 of Convego della Salute, Ferrara (Italy), May 15–16, 1965. Modena, Italy, Stabilimento Poligrafico Artioli, 1965.

Reduction in absorption dose by workers using conventional apparatus; determination, evaluation, and control of absorption dose; and construction of apparatus and accessories that would lower the absorption dose were the three principal aspects considered in the discussion on protection of workers and patients employing radiological techniques. Factors discussed and listed which aided in reducing the exposure of workers and patients were proper siting of apparatus in the working space; proper siting of control panel; correct orientation of radiation source; limitation and proper filtration of the beam; minimization of skin-focus distance and field size; utilization of shielding, antiscattering diaphragms, dark adaptation, highly luminescent fluorescent screens, automatic exposure regulators, gonad protectors, and adequate dose monitoring; and employment of hard versus soft radiation. The use of television and image-intensification devices in lowering the exposure of patients and personnel during fluoroscopy was also discussed. (auth)

8825 RADIOACTIVE FALLOUT AND THE PREPARATION OF A FARM FOR SHELTER FROM IT. Bilecki, Swietoslaw. Med. Weter. (Poland), 20: 245-6(1964). (In Polish).

The production of fallout by a nuclear detonation and its characteristics are described, and means by which farmers can protect themselves and their livestock from fallout are discussed. Radioactive fallout from air blasts of intermediate intensity can result in irradiation dose rates of ~10 R/hr over an area of ~350 km^2, and one R/hr over an area of 900 km^2 (0.5 R/hr up to 1600 km^2). The main fallout zone can be predicted sufficiently accurately by civil defense personnel to permit warning of the population. Since radioactive material can be incorporated in people and animals through breathing and through food and water intake, farmers should prepare for the hazards of radioactive fallout. The farmer should prepare his cellar for occupancy during the fallout period. If he has no cellar, he should prepare a shelter with the use of as heavy shielding material as he can obtain. Food, water, and other supplies for a two week period should be put in the shelter. He should also be prepared to clean the hides of his livestock from contamination. He should have a radio available. Barns should be prepared through such measures as banking earth around the walls of the barn. Food and water should be available in the barn, and should be covered with a tarpaulin. The farm well should also be covered or if water is taken from the river, it should be collected before fallout occurs. Feeding of cows should be decreased, their water intake minimized, and calves left with the cows to minimize milking requirements. (TSS)

8826 GLYCOLYTIC PROCESSES IN THE BLOOD AND MUSCLES OF PIGS IRRADIATED WITH LETHAL DOSES OF GAMMA RADIATION. Kalousova, V.; Vranovska, J.; Pawel, O. (Veterinary Research Center, Prague). Voj. Zdravot. Listy, 35: 112-17 (June 1966). (In Czech).

Influence of a dose of 700 R of gamma radiation on the metabolism of glycosides in the blood and in the muscle tissue of pigs was investigated. In pigs that received a lethal whole-body dose of irradiation, glycoside metabolism is disturbed. This results in the upset of the balance between glucose as well as that lactic acid in the blood, and glycogen in the liver. The limitation of oxidative synthesis of lactic acid in the blood is caused probably by the lowered activity of liver phosphorylase. (JPRS)

8827 TREND OF GROSS BETA RADIOACTIVITY IN PLANKTON SAMPLES COLLECTED IN THE ADRIATIC AND LIGURIAN-TYRRHENIAN SEAS DURING 1961–1964. Triulzi, Cesare; Tassi-Pelati, Laura (Centro Informazioni Studi Esperienze, Milan). Rend. Ist. Lombardo Sci. Lett. B, 99: 121-32(1965).

Before the renewal of the nuclear explosions in September, 1961, the levels of radioactive fallout and therefore the plankton contamination had fallen down to extremely low values. With the renewal of explosions radioactivity considerably increased. High values of radioactive fallout did not always correspond to peaks of high rainfall. This is essentially due to the prolonged retention of fission products in the troposphere. The amount of rainfall being equal, it was evident that radioactive fallout was slightly higher on the Po-Adriatic side of Italy than on the Ligurian side. On the contrary, for the plankton samples examined, an inverse effect was noted; that is, the Upper Adriatic appeared to be less contaminated than the Ligurian-Tyrrhenian Sea. About the middle of 1963 maximum radioactive fallout was recorded, which was followed by a maximum level of β activity in the plankton samples which were examined. Generally, plankton samples showed maxima in correspondence with maxima of radioactive fallout values; there was a higher correlation in the Adriatic than the Ligurian-Tyrrhenian Sea. The Adriatic Sea is characterized by a low background activity, a salinity varying between 33% and 38%, and a marked freshwater penetration, mainly from river Po. The Ligurian-Tyrrhenian Sea presents thoroughly different features as far as depth and circulation phenomena are concerned, and its salinity is uniformly high (38%). (BBB)

8828 BONE MARROW DOSE IN FAST NEUTRON IRRADIATION CALCULATED FROM GEOMETRICAL BONE STRUCTURE. PART 2. Yamamoto, Osamu (Hiroshima Univ.). Nippon Igaku Hoshasen Gakkai Zasshi, 26: 446-53(Aug. 1966).

Equations for the estimation of energy absorption in bone marrow with 14.1 MeV neutrons were revised with consideration to scattering angle and energy of protons. The energy distribution of protons was amended by other constituents, excluding hydrogen, in tissue contributing to energy absorption. Absorption of fast neutron energies in tissues is characteristically different from that of x rays, γ rays, and alpha particles with respect to pattern. Energy absorptions by marrow were compared in mice and rats for x rays, γ rays, and fast neutrons. Relative values to tissue equilibrium in mice were 1.09, 1.01, and 0.92 for x rays, γ rays, and fast neutrons, respectively, and 1.06, 1.01, and 0.93 in rats. (TSS)

8829 PRACTICE OF RADIOACTIVE DECONTAMINATION. Wadachi, Yoshiki; Kawano, Yukio (Japan Atomic Energy Research Inst., Tokyo). Nippon Genshiryoku Gakkaishi, 8: 490-3 (Sept. 1966). (In Japanese).

Decontamination procedures used at a radioisotope storage facility contaminated by $^{226}RaBr_2$ in aqueous solution and aerosols of radon and its daughter nuclides are described. (TSS)

8830 AUTORADIOGRAPHY OF THE NATURAL RADIOACTIVITY IN NORMAL TISSUES OF MEN AND ANIMALS. Pobedinskii, M. N.; Feoktistov, V. I.; Funshtein, L. V. (Central Scientific-Research Inst. of Roentgen-Radiology, Leningrad). Zh. Nauch. Prikl. Fotogr. Kinematogr., 11: 321-6(Sept.-Oct. 1966). (In Russian).

The following precautions are stressed in making autoradiographic determinations: absolutely clean photographic material; freedom of the emulsion layer from radioactivity; minimum exposure time in order to avoid accidental irradiation. It is suggested that the work should be carried out away from the radiological laboratory. (R.V.J.)

8831 POSSIBLE RADIOACTIVE CONTAMINATION OF MAN AND HIS ENVIRONMENT BY THE USE OF NUCLEAR POWER IN SPACE. Bleichrodt, J. F.; Blok, Joh. (RVO-TNO, Rijswijk, Netherlands). Ingenieur, 78: G-27-34(Aug. 5, 1966). (In Dutch).

The possibilities of radioactive contamination of man and his environment by the use of nuclear power in space vehicles are reviewed. Methods for the estimation of radiation dose after burn-up of satellites during re-entry into the atmosphere are given. After complete burn-up of a thermo-electric generator fueled with ^{90}Sr, ^{137}Cs, or ^{238}Pu the radioactive material will be spread in the atmosphere and gradually reach the surface of the earth, giving rise to irradiation of gonads, bone, and bone marrow of the world population. The order of magnitude of the radiation dose these organs are exposed to is estimated at 1 mrad/kW of thermal power of the generator. Burn-up of a nuclear reactor after operation during one year at a power level of 10 MW will result in doses of 0.04, 0.33, and 0.11 mrad in gonads, bone, and bone marrow respectively. Calculations were based on the assumption that the radioactive particles are soluble in body fluids. Insoluble particles may give rise to an inhomogeneous dose distribution in the lungs. It is not certain therefore that the calculated doses are the only criteria needed to appreciate the risks involved. (auth)

8832 ON THE CALCULATION OF THE DOSE LOADS FOR THE BONE TISSUE IN CASE OF ACUTE ^{90}Sr POISONING. Malykhin, V. M.; Moiseev, A. A.; Shamov, V. P. Gig. Sanit., No. 9, 62-3(Sept. 1966). (In Russian).

A biological model for the uptake of strontium-90 by humans was used for determining the dose to bone tissue. The integral bone dose was computed considering the amount of activity introduced into the organism during acute poisoning with strontium-90, the amount of activity measured in vivo at arbitrary times during the years following acute poisoning, and the amount of strontium-90 excreted daily (in urine and feces) by the patients following acute poisoning with strontium-90. (R.V.J.)

8833 STUDY OF DOSE FRACTIONATION IN HIGH-ENERGY ELECTRON THERAPY. Kaercher, K. H. (Univ., Heidelberg). Fortschr. Geb. Roentgenstr. Nuklearmed., 105: 353-67(Sept. 1966). (In German).

The histological, histochemical, and clinical results of various fractionation schemes using high energy electrons are described. Advantages from using high single doses with weekly rest periods were demonstrated and compared with usual radiation schemes. (auth)

8834 PENETRATION OF FISSION PRODUCTS OF SHORT HALF-LIFE. Malykhin, V. M.; Shamov, V. P.; Reznik, G. S. Med. Radiol., 11: No. 8, 64-7(Aug. 1966). (In Russian).

The paper depicts the technique of calculating the permissible doses of short half life fission products on the basis of a differentiated determination of the dose on the thyroid gland, kidneys and bone tissue of 15 radioisotopes. The results are given in the form of tables of the initial activity of the dose ensuring a level of 1 rem at different periods after introduction. (auth)

8835 CONDITIONS OF WORK AND THE STATE OF HEALTH IN PERSONS OPERATING ON REACTORS. Guskova, A. K.; Denisova, E. A.; Moiseitsev, P. I.; Korlyakova, E. A. Med. Radiol., 11: No. 8, 37-42(Aug. 1966). (In Russian).

The paper contains the results of hygienic studies and clinical observations over workers operating on new types of scientific-research reactors. Observations cover a period of 2–5 years and reflect the data of investigations carried out in 288 persons of the principal group and 224 — of the control group. The data for this period of observation make it possible to testify to the

fact that the conditions of work on reactors are quite satisfactory and do not cause any unfavorable shifts in the state of health due to ionizing radiation. Also there was found no noticeable influence of other factors of occupational effect. The indices of health and the incidence of individual shifts vary greatly in persons of the principal and control groups, and by the majority of criteria show no essential differences. This enables the authors to state that the existing values of maximal permissible level of irradiation do not lead to changes in the state of health and should be accepted for the present period as clinically substantiated. The principles of organization of dynamic observation over persons operating on reactors, elaborated and used practically, may be recommended for introduction into practice in respect to other occupational groups working in similar conditions. (auth)

8836 POSSIBILITIES FOR REDUCING OCCUPATIONAL RADIATION DOSES IN NON-STANDARD RADIOLOGICAL DEPARTMENTS. Mazovka, N. N. Med. Radiol., 11: No. 8, 42-5(Aug. 1966). (In Russian).

The importance of an individual dosimetric and medical control to provide for a more appropriate assessment of the radiation situation in non-standard radiological departments is emphasized. It is shown that individual dosimetry effected with the aid of dosimeters dK-0.2, practiced in the radiological department of the Kalinin Cancer Center since 1957-1958, made it possible to control the degree of occupational irradiation, helped to bring to light weak points in the protection system and to eliminate them by corresponding instruction of the staff and the use of a protection device. A brief description and 2 figures of N. N. Kurochkin dosimetrist's containers, designed to increase the protection during manual manipulations of ^{60}Co preparations, are presented. The author proposes 2 types of gynecological applicators made of plexiglass, instead of making the preparations ready by hand, and also a variant of concrete screen to protect the staff in "active" wards. The obtained dosimetric results testify to a reduction of occupational exposure in the radiological department. (auth)

8837 DOSE LOADINGS OF THE MEDICAL PERSONNEL OF GYNECOLOGICAL DEPARTMENTS OF MOSCOW ONCOLOGICAL INSTITUTIONS. Korenkov, I. P.; Rozanova, N. A.; Slutskina, S. I. Med. Radiol., 11: No. 8, 45-52(Aug. 1966). (In Russian).

Studies of dose exposures in the medical personnel of gynecological departments showed that they did not exceed the permissible levels. Nurses are subjected to greater irradiation—1.3–1.5 times more than physicians. The dose exposures of physicians during the use of the existing protective equipment mainly depend on their qualification and decrease with prolongation of the service record. (auth)

8838 INTERNATIONAL CIVIL DEFENSE SYMPOSIUM ON NUCLEAR RADIATION HAZARDS, 12 TO 16 May, 1964. Geneva, International Civil Defense Organization, 1964. 56p. (CONF-640514).

Defense measures against nuclear radiation hazards are considered. Topics discussed include accidental contamination and safety measures in nuclear centers and laboratories, fire preventive measures in enterprises using radioactive sources, development of legislative problems of nuclear energy and insurance, radiological self-protection in industry, training of decontamination team and methods of evacuation of radioactive waste, multi-purpose shelter construction, dose-rate measurements using G. M. Counter, experience in the measurement of radioactivity in the biosphere and problems arising in case of accidental contamination, fallout contamination of the biosphere, radioactivity monitoring in Finland, Geiger counter vs dosimeter as the ideal civil defense radiation detection instrument, some biological diagnostic tests of the radiation doses following whole-body irradiation, possible hazards to man through the contamination of food with man-made radionuclides, decontamination principles for drinking water and practical application, and a new method for determination of strontium-90 in water using chelating extraction and its technical applicability. (H.L.W.)

8839 EXPERIMENTAL DATA ON TISSUE DOSES PRODUCED BY MONOENERGETIC NEUTRONS IN HUMAN PHANTOMS. Keirim-Markus, I. B.; Kochetkov, O. A.; Obaturov, G. M.; Tsvetkov, V. I. Vienna, International Atomic Energy Agency, 1966, Preprint No. SM-76/45, 18p. (In Russian). (CONF-660807-19). ORAU.

From Symposium on Neutron Monitoring for Radiological Protection, Vienna.

The component distribution of a tissue dose produced by monoenergetic neutrons (energies: 130, 280, and 500 keV; 1, 2.5, and 5 MeV; and thermal) was investigated for different flux directions in the tissue-equivalent phantom of a standard human torso. Dose components produced by $^{14}N(n,p)^{14}C$ and $^{1}H(n,\gamma)^{2}H$ reactions and by recoil protons were studied. Activation detectors and photographic film with intensifying screens were used to determine the thermal neutron flux; alumophosphate glass thermoluminescent dosimeters were used for determining gamma dose; and nuclear emulsions were used for determining the recoil proton dose. The results are compared with those given in the literature. (auth)

8840 GEORGIA RADIUM MANAGEMENT PROJECT. PHASE I. A STUDY OF THE RADIOLOGICAL HEALTH ASPECTS OF THE USE OF RADIUM IN HOSPITALS. Benson, James S.; Fetz, Richard H. 5p. (CONF-660621-18). ORAU. Gmelin, AED-CONF-66-193-15).

From Health Physics Society, 11th Annual Meeting, Houston, Tex.

Results are reported from a survey of radioactive contamination due to the use of radium sources in 24 hospitals located in Georgia. Alpha contamination was found at 16% of the hospitals, γ activity in storage rooms was above recommended limits at 33% of the hospitals, and leaks were found in radium sources used at 46% of the hospitals. (C.H.)

8841 INFORMATION OF THOROTRAST DOSIMETRY SUPPLIED BY THE RADIOCHEMICAL ANALYSIS OF TISSUE SPECIMENS. Parr, Robert M. (International Atomic Energy Agency, Vienna). 20p. (CONF-660422-1). ORAU. Gmelin, AED-CONF-66-178-3.

From Conference on Distribution, Retention, and Late Effects of Thorium Dioxide, New York.

Problems in the radiation dosimetry of injected Thorotrast in man are reviewed. The injected colloidal material is retained in the reticuloendothelial system of the patient throughout life. The major part of the radiation dose from Thorotrast is contributed by seven isotopes that emit α particles, all of which are short-lived except ^{228}Th and ^{232}Th. Methods are described for the analysis of tissue samples for radioactivity due to Thorotrast. These include measurements of γ activities from ^{228}Ac, ^{212}Pb, and ^{208}Tl made over a period of months; measurements of ^{232}Th activity in various tissues; measurements of ^{212}Pb and ^{212}Bi activity in various tissues; determination of the relative activities of thorium decay isotopes in various body tissues; and studies of mechanisms affecting the retention of Thorotrast particulates in various tissues. (C.H.)

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Refer also to abstracts 8694, 8695, 8697, 8771, 8814, 8818, 8819, 8821–8823, 8925, 8926, 8949–8951, 8973, 8995, 8998, and 9000.

8842 (AD-630292) THE MEDICAL BURDEN FROM SKIN BURNS AT NAGASAKI: A REAPPRAISAL. Progress Report No. 11. Mixter, George Jr. (Naval Applied Science Lab., Brooklyn, N. Y.). Oct. 12, 1965. 25p. (DASA-1721). CFSTI $2.60 cy, $0.50 mn.

The medical burden at Nagasaki i.e., the number of persons who required medical care as a result of receiving skin burns caused by thermal radiation, was determined as a function of the distance from ground zero and radiant exposure. The casualties were computed on the basis of available burn casualty and survival data and a re-estimate of burst conditions. Of an initial population of approximately 174,400 persons, 8355 or 4.5 % of the total population survived 20 days after the detonation after receiving serious burns. Of the 20-day survivors, 1800 had been closer than 1000 meters to ground zero, 13.5% of whom had skin burns. A total of 5800 20-day survivors had been at distances of from 1500 to 2000 meters 18.1% of whom had skin burns. Of the 54,600 survivors who had been at distances of from 4000 to 5000 meters, only 2.9% had skin burns. The data are presented in a form to allow estimates of casualties for situations resembling those at Nagasaki. From an analysis of the casualty data and from estimates made by Japanese doctors of the number of persons who survived immediately after the detonation, a casualty rate curve has been derived for the 20-day interval following the detonation. (auth)

8843 (AD-634723) PREDICTION OF EYE SAFE SEPARATION DISTANCES. Report for January–February 1966. Richey, Everett O. (School of Aerospace Medicine, Brooks AFB, Tex.). June 1966. 28p. CFSTI $2.00 cy, $0.50 mn.

A method is given for predicting the distances at which the thermal radiation from nuclear detonations will be hazardous to the unprotected human eye. This method relates calculated retinal exposure to experimentally determined eye effects data. Eye hazards as a function of distance are determined for the unprotected human eye exposed to sea-level, air-burst detonations from 0.01 to 10 kt yield. The pupil diameter of the human eye is taken to be 2.5 mm and 6.0 mm respectively, for day and night conditions and the effective focal length of the eye is taken to be 17 mm. Nu-

clear detonation characteristics and scaling factors are taken from Glasstone's "The Effects of Nuclear Weapons." The results indicate that the eye hazard is the limiting factor in determining the distance of nearest approach to a nuclear detonation unless eye protection is provided. Eye hazards as a function of distance are also determined for the human eye protected from daytime detonations by a 2% transmission fixed filter. The results indicate that use of such a filter will provide eye protection at distances where other hazards become limiting factors. (auth)

8844 (COO-78-142, pp 138-41) RADIATION PHYSIOLOGY AND MODIFIERS SECTION. (Western Reserve Univ., Cleveland, Ohio. School of Medicine).

Progress is reported in the evaluation of labeled compounds for use in diagnostic studies. The possibility of using ^{75}Se-selenomethionine for pancreatic scans was evaluated in guinea pigs. Data from the study showed that the pancreas was readily identified in about 60% of the animals but that uptake by organs in close proximity to the pancreas interferred with scanning. Preliminary studies showed that ionic resin had no value as a vehicle for radioisotopes to be used in diagnostic and therapeutic procedures involving the liver. The use of ^{86}Rb, ^{42}K, and ^{131}Cs for the visualization of normal myocardium, myocardial infarction, and other disturbances of cardiac blood supply by radioisotope scanning technique was investigated. It was concluded that ^{131}Cs in the form of Cs acetate was the most satisfactory of the isotopes studied. (C.H.)

8845 (EUR-3122.e) INVESTIGATIONS ON BONE MARROW TRANSPLANTATION IN IRRADIATED ANIMALS AND THE PRODUCTION OF SPECIFIC PATHOGEN FREE ANIMALS AND THEIR APPLICATION IN RADIOBIOLOGY. Report Covering the Period, December 1, 1962–December 31, 1965. (Nederlandse Organisatie voor Toegepast Natuurwetenschappelijk Onderzoek, Utrecht). June 22, 1966. 39p. Dep. mn.

The program on bone marrow transplantation consisted of fundamental studies performed with mice and rats, as well as preclinical experiments with monkeys. Among the most notable results are the successful homologous bone marrow transplantation in irradiated rats, which is partly to be ascribed to the use of specific pathogen free animals; the successful suppression of the acute secondary disease in monkeys following transplantation of homologous marrow; the development of an effective method of preservation of monkey bone marrow at low temperatures; the identification of leukocyte antigen groups probably representing tissue transplantation antigens in Rhesus monkeys; the introduction of a new technique for the identification of antibody forming cells in vitro; and the interpretation of the post-thymectomy wasting syndrome as a form of autoimmune disease. The project of specific pathogen-free animals progressed significantly. Specific pathogen-free rats have become a standard object of radiation studies. The project moved in the direction of the production of animals with a completely defined and controlled microflora, in addition the methods originally developed for the maintainance of these animals are now being applied clinically in the barrier nursing of patients with a severely diminished resistance against infection. Much attention was given to this application especially because of its potential use for irradiated patients. Large numbers of germfree mice were made available for experimental purposes, and they served to study a variety of problems in radiobiology, immunology and hematology. (auth)

8846 (MIT-952-3, pp 1-201) RADIUM AND MESOTHORIUM TOXICITY IN HUMAN BEINGS. (Massachusetts Inst. of Tech., Cambridge. Dept. of Physics).

Studies on 56 cases of radium and/or mesothorium poisoning are reported. Some aspects of the study are as follows: results on radium and mesothorium measurements; survey of MsTh/Ra ratios; fractional radon retention vs. time after exposure for 37 radium cases; rate of elimination of radium; measurement of macroscopic variations in the skeletal distribution of radium and mesothorium; semi-microscopic distribution of radium and its daughters in bone; microangiographic studies on autopsy cases; microradiographic study of hypermineralization of Haversian canals of bone; dose variables, effect of skeletally deposited alpha-ray emitters in man, case history summaries. (H.L.W.)

8847 (ORNL-3999, pp 140-2) CHEMICAL PROTECTION AND ENZYME CATALYSIS. (Oak Ridge National Lab., Tenn.).

Progress is reported on a procedure to evaluate protective compounds that at a single lethal 900-R dose gave complete survival of mice. Dose response curves for MEA and AET are given. Results obtained with mixtures of glutathione and AET indicate that glutathione plays a role in protection beyond that of reducing the toxicity of AET. Studies on detoxifying disulfides indicate that they do not seem to be a reasonable route toward greatly increased protective activity. Progress is reported on studies on peptide and protein modification and the catalytic properties of pepsin. (H.L.W.)

8848 MULTICENTRIC UNILATERAL RETINOBLASTOMA TREATMENT BY RADON WITH SEVEN-YEAR CURE. Henderson, John W.; Van Herik, Martin (Mayo Clinic, Rochester, Minn.). Amer. J. Ophthalmol., 61: 1140-5(May 1966).

Use of intracavitary radon therapy is advocated in the treatment of retinoblastoma and a case report is presented to illustrate the dose, technique, application, and precautions needed to prevent complications. The intracavitary optic applicator described was thought to offer the best means of administering localized high-dose therapy in the shortest possible time. A 3500 to 4000 R gamma ray dose was chosen as the critical dose. Within a few hours after administration, the dose was found to be lethal to the neoplasm. Precise calculation of the dose and precision positioning of the applicator prevented irradiation cataract. That cataract development as a late complication may occur was not ignored; clear media have so far permitted normal visual function. It was estimated that the lens of the treated eye received a total of 565 R in the two periods of treatment. This amount was considered to be near the minimal dose that is capable of producing lens opacities. (TSS)

8849 CONSERVATIVE TREATMENT OF RETINOBLASTOMA. Stallard, H. B. Trans. Ophthalmol. Soc. U. K., 82: 473-535(1962).

Complications of radiation treatment of ocular tumors, with ^{60}Co contact applicators, are described with reference to 83 patients. Most of the complications in irradiated eyes which have retained some vision have occurred because of excessive irradiation of multiple islands of retinoblastoma, particularly when large masses are near or adjacent to the optic disc and involve the larger branches of the central retinal vessels. Although the vascular changes induced by irradiation play an important part in the destruction of the neoplasm they are also responsible for such late complications as intra-ocular hemorrhage and irradiation cataract, and for the low healing of a divided extra-ocular muscle and a conjunctival incision when the radioactive applicator has been placed unavoidably near these incisions. (TSS)

8850 PROGNOSTIC IMPORTANCE OF CHANGES IN THE PERIPHERAL BLOOD IN ACUTE RADIATION DISEASE IN THE STATE OF ACUTE HEMORRHAGE. Zografov, D. G. (Scientific Research Inst. of Radiology and Radiation Hygiene, Sofia). Rentgenol. Radiol., 4: No. 1, 44-9(1965). (In Bulgarian).

A correlation is made of changes in the blood and the survival period in two groups of guinea pigs irradiated on the third day after bloodletting. It is established that changes in the erythrocyte count have prognostic value. The degree and rate of development of anemia was important in both groups. A transitory increase in erythrocytes toward the sixth day and the degree of reticulocyte crisis were of importance in the test animals irradiated on the third day. (auth)

8851 THE DESIGN OF ALUMINIUM WEDGE FILTER FOR USE ON ^{60}Co TELETHERAPY. Urano, Muneyasu; Yamada, Chikahisa (Kyoto Prefectural Univ.). Nippon Igaku Hoshasen Gakkai Zasshi, 26: 258-63(June 1966). (In Japanese).

Wedge filter technique is used to irradiate malignant tumor tissue with tumor lethal doses and this method has been used not only for x ray therapy, but also for ^{60}Co and high energy therapy. The design of a wedge filter made of Al for use in ^{60}Co teletherapy is described. (auth)

8852 CHANGES IN OXIDATIVE PROCESSES IN THE TISSUES OF IRRADIATED ANIMALS UNDER THE EFFECT OF MONOETHANOLAMINE. Babina, E. Ya. (Erevan Zootechnical-Veterinary Inst.). Dokl. Akad. Nauk Arm. SSR, 42: No. 1, 31-5 (1966). (In Russian).

Roentgen irradiation at a dose of 650 R induced an increase in lipid peroxides and a drop in respiration in the tissues of the liver and spleen of white rats. Monoethanolamine decreased the content of lipid peroxides both in the liver and spleen of irradiated animals, the greatest decreases occurring on the 4th to 5th day in the case of the liver, and on the 4th to 6th day for the spleen. Monoethanolamine increased the oxygen requirement of tissues of the liver and spleen of irradiated rats from the very first hours after irradiation up to the 11th day of the radiation sickness. Decrease in the lipid peroxide content and increase in tissue respiration in the liver and spleen of white rats in the course of radiation sickness under the effect of monoethanolamine explains to some degree the mechanism of the protective action of monoethanolamine on irradiated male white rats. (JPRS)

8853 EFFECT OF NOVOCAINE INTRAARTERIALLY ADMINISTERED ON THE COURSE OF EXPERIMENTAL ACUTE RADIATION SICKNESS. Dashkovskaya, V. S.; Berkman, R. A. (Sklifosovskii Inst., Moscow). Eksp. Khir. Anesteziol., 10: No. 5, 76-7(Sept.–Oct. 1965). (In Russian).

Sixty rabbits 2.5 to 3 kilograms in weight were exposed to the action of x rays in doses of 1,000 R. The animals were divided into three groups: one experimental and two controls. Two series of experiments were carried out. In the first series the experimental animals were given a 0.5 percent solution of novocaine calculated for doses of 2.5 milliliters per kilogram body weight into the ear artery 30 minutes after the irradiation; the injection of the novocaine in the same doses was repeated during the next two days. The animals of control group A, although irradiated simultaneously with the experimental rabbits, did not receive the novocaine; control group B was given novocaine intravenously. In the second series of experiments one group of the animals was given novocaine after preliminary injection of barbamyl. The experiments established that novocaine intraarterially administered to the animals irradiated with doses of 1,000 R aggravated the manifestations of radiation sickness; the survival rate of the animals decreased as a result of the intraarterial administration of novocaine (24 of the 30 rabbits perished); barbamyl in a number of cases prevented the negative effect of novocaine intraarterially administered. (JPRS)

8854 EFFECT OF A NUCLEOTIDE MIXTURE (NUCLETON) ON THE DEPRESSION OF DNA SYNTHESIS BY IONIZING RADIATIONS IN REGENERATING MOUSE LIVER. Kido, K.; Tanaka, T. (Kyoto Univ.). Nippon Igaku Hoshasen Gakkai Zasshi, 26: 382-5(July 1966).

Restoration from radiation-induced depression of DNA synthesis was observed in regenerating mouse liver after the administration of an alkaline-hydrolyzed product of yeast RNA (Nucleton). The surgical procedure to obtain regenerating liver in the mouse is described in some detail. Biochemical mechanism of the restoration is discussed. (auth)

8855 PUBLIC HEALTH SERVICE REPORT OFFERS GUIDE. Ingraham II, Samuel C.; Barnett, Mark; Taylor, Wilbur R. (Public Health Service, Washington, D. C.). Mod. Hosp., 105: 112-15(Nov. 1965).

This report is designed to aid architects, planners, and administrators in the design of radioisotope installations in general hospitals of small or moderate size. Attention is given to safe techniques and facilities to eliminate unintentional and potentially harmful radiation exposure to both personnel and patients when radioactive compounds are handled and administered. In designing and constructing radioisotope facilities, the possibility of both external and internal hazards must be considered. For safety and control, it is usually preferable that the hospital designate one department for radioisotope handling rather than allow all departments to administer radioisotopes to patients. Usually, the radiology department is in charge of radioisotopes. The location of inpatients who have received radioisotopes is an important consideration. Inpatients who have received diagnostic doses generally do not require special bed areas or special toilet facilities, but those receiving therapeutic doses may present complex problems. Some examples are cited. Because the installation of heavy lead radiation shielding in patient care areas is highly impractical, the location of the therapy patient's bed must be given careful thought. Sufficient distance must be maintained between the radioactive patient and other persons to keep the radiation exposure below acceptable limits. The staffing of a radioisotope facility, which will vary according to the work load and the variety of procedures undertaken, is discussed. A brief description of the general kinds of activities performed in the radioisotope department is given to provide some idea of the space and equipment required. (BBB)

8856 REACTIVITIES OF RADIATION-PROTECTIVE AMINOALKYLISOTHIURONIUM SALTS. I. HYDROGEN ION LIBERATION OF 2-AMINOETHYLISOTHIURONIUM AND 3-AMINOPROPYLISOTHIURONIUM BROMIDE HYDROBROMIDE. Hanaki, Akira; Hanaki, Tomoko; Oya, Kazumi; Andou, Atsushi; Hino, Tohru; Akaboshi, Sanya (National Inst. of Radiological Sciences, Chiba, Japan). Chem. Pharm. Bull. (Tokyo), 14: 108-13(Feb. 1966).

When alkali was added to a solution of AET or APT a rapid pH drop was noted which continued for two or three hours. This pH drop may be related to a reaction involved in acid dissociation of the thiuronium salt. However, it is uncertain whether the pH drop is a result of transguanylation or cyclization or other reactions. A study was made of why AET and APT in aqueous solution liberate hydrogen ion in the presence of alkali. In the presence of alkali, of less than one equivalent with respect to aminoalkylisothiuronium salt, hydrogen ion liberation was observed. With alkali in amounts of more than one equivalent, hydrogen ion liberation did not occur. This reaction was attributed to intramolecular transguanylation which was accompanied with the acid dissociation of AET and APT. The rate of hydrogen ion liberation was more than 20 times faster in AET. In the absence of alkali, AET was transformed to 2-aminothiazoline and ammonium ion was split off, while the cyclization of APT was not observed under the same conditions. The activation energy of hydrogen ion liberation from AET was 20 or 30% larger than that from APT, in spite of the high reactivity of AET. On the other hand, the frequency factor of hydrogen ion liberation may be more than 40 or 50 times larger in AET. This difference might be attributed to the probability that a reaction intermediate is produced. The intermediate from AET might have a five-membered ring and that from APT a six-membered ring. Thus, the frequency factor is of most importance on the rate of hydrogen ion liberation from aminoalkylisothiuronium salts. (BBB)

8857 RECENT CRITERIA IN THERAPY OF CUTANEOUS AND MUCOSAL HEMANGIOMAS, WITH PARTICULAR REGARD TO THE USE OF ^{90}Sr. Baroncelli, G. (Spedali Civili, Brescia, Italy). Minerva Med., 56: 3392-403(Oct. 6, 1965). (In Italian).

The use of β applicators, especially ^{90}Sr, in the treatment of 97 simple and 179 cavernous hemangiomas is reported, along with techniques for protection of healthy tissue and the occurrence of complications. Avoidance of irradiation of adjacent healthy tissue by use of β applicators, as compared with the use of x and γ rays, which irradiate healthy structures including the gonads, is a principal reason for employment of ^{90}Sr in this condition. Attenuation of dose in the skin with various types of soft radiations is compared. The 2.23-MeV β ray of ^{90}Sr is ideal for irradiating superficial skin lesions such as hemangiomas. About 50% of the dose is absorbed in the first millimeter of tissue. In general, single doses of 1500 to 2000 rep were used, repeated two to three times at intervals of 45 to 70 days, giving total doses of 4500 to 5000 rep. Eight to 15 days after irradiation the skin became erythematous, and in 12 of the 276 patients treated radioinduced ulcers formed. In about 10% of the cases the irradiated skin became moderately atrophic and discolored. (BBB)

8858 PROPHYLACTIC USE OF RADIOACTIVE GOLD IN THE TREATMENT OF PRIMARY OVARIAN CANCER. Keettel, William C.; Fox, Michael R.; Longnecker, Daniel S.; Latourette, Howard B. (Univ. of Iowa, Iowa City). Amer. J. Obstet. Gynecol., 94: 766-79(Mar. 15, 1966).

Complications occurring among 209 patients with primary ovarian cancer treated with ^{198}Au colloid instillations are reported. The amount of radiogold used varied from 88 to 225 mC, most cases receiving one injection of 150 mC. Eleven patients received a second injection within 2 to 7 months to control ascitic fluid formation. Most patients had either minor transient complications or none at all. (TSS)

8859 IMAGE INTENSIFIER COMPARED WITH CONVENTIONAL FLUOROSCOPY FOR ROUTINE GASTROINTESTINAL INVESTIGATION. Marshall, R. T. (Auckland Hospital, New Zeal.). J. Coll. Radiol. Austral., 9: 295-6(Oct. 1965).

Diagnostic effectiveness and radiation dose received by patients and operators were compared in fluoroscopy with and without an image intensifier. A controlled series of examinations was conducted over one yr on 500 patients. Of two screening rooms used, one was equipped with a Siemens 7-in. intensifier, while the other has only conventional facilities. Analysis of the results showed that viewing with the intensifier demonstrated an abnormality in 34% of cases, while a lower figure of 26.5% was obtained on conventional screening. However, subsequent study of the films exposed by each method brought the number of abnormalities found on conventional screening almost up to the level found with the intensifier. In other words, films gave additional findings in a higher proportion of cases when the intensifier was not in use, the ratio being 67% to 34.5%. Whether the patient dose and observer dose of radiation is reduced was also analyzed by comparison of the exposure level in milliampere-seconds. To determine this, the average screening time was multiplied by the normal screening milliamperage. The average doses with and without the intensifier were 232 and 343 mamp-sec, respectively. It was apparent that although screening time is longer with the intensifier, the lower milliamperage used results in a reduction in screening milliampere-seconds compared with conventional fluoroscopy. It is stressed also that the small field of observations which usually applies with the intensifier alone reduces still further the dose to both patient and observer. (BBB)

8860 BONE SCANNING FOR METASTATIC CANCER WITH RADIOACTIVE ISOTOPES. Greenberg, Ernest J.; Rothschild, Edmund O.; DePalo, Angelo; Laughlin, John S. (Sloan-Kettering Inst., New York). Med. Clin. N. Amer., 50: 701-10(May 1966).

Bone scanning with ^{47}Ca and ^{85}Sr has proved important in the early diagnosis of bone lesions, and is essential in the study of their metabolism. With the quantitative methods that have been developed it has been possible not only to locate lesions in early stages, but also to study their metabolism of specific isotopes over long periods of time and to follow their retention by the body as a whole over extended periods exceeding two years, in some

instances. Calculations were made of the radiation doses to bone and to the whole-body when 100 μC of each of these two isotopes are entirely retained and completely decayed in the skeleton. It was determined that there is a contamination of ^{47}Ca with 10% or less of ^{45}Ca, depending upon enrichment. Accounting for all the β and γ emissions of the ^{47}Ca and its ^{45}Ca contaminant in 100 μC of ^{47}Ca, the total radiation dose to bone was found to be 4.2 rad, with 0.3 rad to the whole-body. For ^{85}Sr the dose to bone was found to be 4.7 rad and 3.2 rad to the whole-body. Since there is a constant elimination of these isotopes and since this is larger for strontium than for calcium, the radiation doses resulting from the administration of 100 μC of either are much smaller than the figures mentioned above. The isotope is injected intravenously as a single dose of 50 to 100 μC. Rarely have larger doses been used. When studies were carried out on patients with known metastatic cancer in bone, it was possible to observe the effect of such lesions on the local uptake of ^{47}Ca or ^{85}Sr in the neoplastic as well as uninvolved parts of the skeleton. A further step in the study of the uptake of ^{47}Ca and ^{85}Sr in bone invaded by tumor was the evaluation of the local kinetic state of these isotopes. When ^{85}Sr is used, the uptake in the portion of bone invaded by actively growing tumor rises sharply to a greater extent than in normal bone in a manner similar to ^{47}Ca. However, this rise is not sustained and a decrease is frequently observed after 24 to 48 hr. The uptake measured over normal bone rises for ~24 hr and then it decreases slowly and steadily. There is an increasing interest in the use of isotopes with a half-life shorter than that of ^{47}Ca. Strontium-87m with a 2.8-hr half-life and ^{18}F with a 1.9 hr half-life have also been used for detection of bone lesions. The theoretical advantage of these isotopes is that their short half-life results in a decrease in the amount of radiation delivered to the patients. Their disadvantages are that a source of production of these isotopes must be close to their site of use and that their rapid decay makes immediate scans imperative and repeat measurements impossible in cases where early results are equivocal. (BBB)

8861 LYMPHOGRAPHIC CONTROL OF MEGAVOLT THERAPY IN CANCER OF THE FEMALE GENITALIA. Gerteis, W. (Medizinische Akademie, Duesseldorf, Ger.). Arch. Gynaekol., 202: 320-5(1965). (In German).

Lymphography was used to follow the effects of irradiation on the lymphatic system in six cases of gynecologic cancer, and to assess the individual differences in reaction to maximum radiation doses and thereby enable control of tissue damage. In supervoltage therapy, lymphography demonstrated the sclerosing action of radiation on connective tissue and radioinduced atrophy of lymph nodes. Local doses of 3000 to 4000 R were usually reflected by changes in the lymphogram. Some metastases in lymph nodes proved to be radioresistant as shown by their persistence after doses of 5000 R. Lymphography proved to be of value in revealing whether lymphatic metastases regressed after various doses. Excessive doses to normal tissues could be prevented by examination of the lymphography results at advancing stages of radiotherapy. When evidence of radioresistance appeared, surgical treatment could be resorted to. In the 400 lymphograms that were examined, regression of metastases after radiotherapy was noted in 64.3% of cases. (BBB)

8862 CONVENTIONAL SCANNING VS. SCINTILLATION CAMERA: A COMPARISON FOR EVALUATION OF BRAIN PATHOLOGY. Loken, Merle K.; Telander, Gerald; Laxdal, Stefan (Univ. of Minnesota Hospitals, Minneapolis). Minnesota Med., 49: 237-41(Feb. 1966).

A detailed comparison of results of organ visualization by conventional scanning to those obtained with the scintillation camera is provided. This study includes all organs which may be visualized using selected radioisotopic preparations. Special attention is given to short-lived radioactive materials which will permit improved resolution and decreased radiation exposure to patients despite administration of relatively larger amounts of these materials than are normally employed for conventional scanning. These studies were performed with mice, a brain phantom, and patients suspected of having brain tumors. Special consideration was given to the use of ^{99m}Tc in the form of pertechnetate for brain studies, and comparison was made with results obtained with ^{197}Hg-chlormerodrin. Both agents were used for camera and scan studies in individual patients. When mice were given 100 mC ^{99m}Tc intravenously, it was found to be handled very much like radioiodine. At one hour most of the ^{99m}Tc removed from the blood stream was found in the salivary glands, thyroid, and stomach. These data indicate that the radiation exposure to patients is quite low despite the use of 10 mC for an adult patient. The use of large amounts of radioactive materials in patients is frequently contraindicated because of radiation hazards involved. This problem may be eliminated, at least in part, by using very short-lived radioactive materials such as ^{99m}Tc. Advantages of the camera also include the shorter time per projection (two to four min as compared with 15 to 30 min for a conventional scan), and the ease of positioning the camera. (TSS)

8863 NEW LAYOUT FOR GENITO-URINARY RADIOGRAPHY. Whitehead, G. (Leicester Royal Infirmary, Eng.). Radiography, 32: 123-6(June 1966).

A new arrangement of x-ray facilities for intravenous and retrograde pyelography is described and illustrated, which is particularly designed to reduce patient and staff exposure. The use of a ceiling-suspended x-ray tube is essential to this design. Along with the ceiling-mounted tube unit, four tables are positioned in the form of a square, two of these tables being mounted on floor tracks. This system provides an easy and efficient way of carrying out up to three intravenous pyelograms, with provision for a fourth, such as a retrograde pyelogram. Little effort is required to move the x-ray tube over to any of the four tables. The height of the tube is adjusted by motor drive with the simple operation of a switch; centering is simple and magnetic brakes are used for locking the tube in position. The Potter-Bucky trays are of the reciprocating type with magnetic locks. Four exposure switches are situated behind a protective shield, one for each table, the respective Bucky tray being selected via a relay. The Leicester Gonad Protector is attached to the light beam diaphragm, facilitating easy protection of the gonads, especially in the male. The room is capable of accepting 18 intravenous pyelograms per day. Adequate protection from stray radiation is provided by the lead plymax and lead glass arrangement on three sides of each table. The underside of each Bucky tray is protected with a sheet of lead to absorb any transmitted radiation from the tray to prevent it from back-scattering off the x-ray room floor. Each patient is fully protected from stray radiation. Closer watch on children through the lead-glass window gives the child more confidence, and the radiographer can watch respiration, therefore achieving better exposure control. (BBB)

8864 BIOLOGICAL EFFECT OF LASER ENERGY ON HUMAN MELANOMA. Helsper, James T.; Sharp, George S.; Williams, Herbert F.; Fister, H. William (Pasadena Tumor Inst., Calif.). Cancer, 17: 1299-1304(Oct. 1964).

Effects of laser energy on pigmented and unpigmented cells in tissue culture were studied by time-lapse microphotography, and experiments on human melanomas were also conducted. In the tissue culture studies, after exposure to a weak laser beam of 25 J/cm^2, the pigmented cells were killed instantly while the nonpigmented ones appeared unaffected, even in the case of an incidental mitosis that continued unchanged. Following these studies, a benign nevus excised from a patient was treated with the laser at the center of the lesion using a target of 0.25 mm in dia. A small area of necrosis appeared in the center of this lesion. Tissue destruction occurred only in the pigmented basal layer of the epithelium, while the nonpigmented, supporting tissues appeared unharmed. Metastatic melanoma nodules treated with laser radiation showed varying degrees of necrosis, and in some cases complete eradication of the tumor. While unstained, nonpigmented tissue showed no detectable effect, these studies were extended by artificially pigmenting a human adenocarcinoma in situ, prior to laser irradiation. Although some effect has been observed, it has not been as extensive as that seen in patients with malignant melanoma in which the pigmentation occurs naturally. These investigations were done with Janus green, India ink, and Wright's stain, applied at the time of surgical exposure just before the laser firing. Studies at the tissue culture level were also done in an attempt to discover if a cytotoxic product is formed from the highly localized heat of the laser energy within the tumor nodule itself. Such an occurrence might account for the effects observed. A possible explanation may be in a new compound that is formed by the laser. Preliminary results suggest that such a material does exist. (BBB)

8865 EXPERIMENTAL CONTRIBUTION TO THE UTILIZATION OF FOUR BASIC METHODS OF ANESTHESIA DURING ACUTE RADIATION SICKNESS. Pokorny, Jiri; Pospisil, Jan. Voj. Zdravot. Listy, No. 1, 14–18(1966). (In Czech).

The toxicity of anesthetics in irradiated animals was investigated. Dogs weighing an average of 30 kg and aged 1 to 6 years were used. Four groups of dogs received anesthesia but were not irradiated; received anesthesia 24 hours after irradiation; were given anesthesia 7 days after irradiation; or were irradiated but not given anesthesia. The dogs were irradiated with a mean dose of 300 R. Exposure duration was 60 minutes. The dogs were observed for 90 days, but no changes were detected after 50 days. Thiopental, ether, trichlorethylene, and thiopental by alcohol infusion were used as anesthethics. Inhaled anesthesia with trichlorethylene yielded surprisingly good results; the mortality rate of the animals in that group was lower than in the control group. Intravenous anesthesia of thiopental with alcohol infusion

was found to be unsuitable. It was observed that anesthesia administered on the 7th day after irradiation was safest. Dosimetric control during the tests was carried out. (ATD)

8866 RETINAL PHOTOTHERAPY. Ingram, H. Vernon (Royal Victoria Infirmary, Newcastle upon Tyne, Eng.). Proc. Roy. Soc. Med., 59: 215-23(Mar. 1966).

Rabbit experiments and clinical investigations on the effect of laser radiation on the eye are reported, and protection of operators of lasers in research and therapy is dealt with. Complications of laser treatment are also considered. In irradiating the eye, it was found best to commence with a low energy and gradually increase it until the desired effect is obtained. The ideal lesion seemed to be accompanied by a small subretinal bubble in its center. An increase in energy produced a larger bubble, which broke through into the vitreous, or a small hemorrhage. With the instrument described, this tended to occur with input energies over 560 J. This hemorrhage soon absorbs, often within 24 hr, and does not cause complications, nor does it detract from the result. Nevertheless, it is undesirable and should be avoided. Pigmentation develops early. A fine pigmented halo is often seen round the spot within a few minutes of the application. This is probably due to disruption of the pigment epithelial cells releasing the pigment granules which are pushed aside by the explosive lesion. The bubble, which is probably carbon dioxide and steam, absorbs quickly. The results indicate that the laser beam does not produce its effect by conversion of the energy into heat, causing coagulation of the proteins. The only heat production with the laser is due to acceleration of the molecular fragments in the lesion. This thermal effect is secondary. The laser lesion represents an electromagnetic disruption of the tissues at the spot where the beam is focused. This explains the immediate appearances of the lesion produced. Except for the small retinal hemorrhages referred to, which indicate too great an energy, the only complications encountered have involved the iris. If the beam hits the iris instead of passing completely through the pupil, it soon produces contraction. If the range of energies which are clinically useful are exceeded, the effects are disastrous and become increasingly so the more the energy is raised. Most of the laser beam of 6943 Å is transmitted by the clear media, but even the cornea and lens are affected if dose is sufficiently high. Effects are described in detail as seen with a wide range of energies from 0.05 to 25 J. (BBB)

8867 COMPUTER APPLICATIONS IN NUCLEAR MEDICINE. Robertson, James S. (Brookhaven National Lab., Upton, N. Y.). J. Chron. Dis., 19: 443-59(Apr. 1966). (BNL-9133).

Applications of computers in nuclear medicine are considered under three headings: tracer studies, activation analysis, and radiation effects and dosimetry. A review of the recent literature, as well as a discussion of current work of the author's lab, is presented. Three principal categories of tracer studies involving computer applications and radioisotopes discussed are: tracer theory and kinetic studies, γ-ray spectrum analysis, and scanning. One of the most comprehensive and successful digital computer programs for analyzing tracer experiments, the NIH-OMR-SAAM program, written in FORTRAN II for use by IBM-7094 computers, is described. An example of the use of computer methods for data processing is illustrated by a description of the multidetector positron scanner under development at Brookhaven National Lab. One use of computer programs in activation analysis is for determination of the optimal activation and decay time combination for each element of a complex mixture. A FORTRAN program designed to achieve this has been developed. Radiation dosimetry provides one of the most immediately practical and readily exploited areas of nuclear medicine for computer applications. Examples of both clinical and experimental situations are cited. Studies by the author, using an IBM-7094 computer program, TRITIUM, to recalculate the dose distribution about a point source and to compute the absorbed doses in a series of spheres are presented. (BBB)

8868 FACTORS CONTRIBUTING TO SEVERITY OF HERPES ZOSTER IN CHILDREN. Bacon, George E.; Oliver, William J.; Shapiro, Barry A. (Univ. of Michigan, Ann Arbor). J. Pediat., 67: 768-71(Nov. 1965).

Three cases are described in detail in which radiotherapy and/or treatment with other immunosuppressive agents were believed to have aggravated this disease. Herpes zoster occurs infrequently in childhood, and is generally benign, self-limited, and associated with little discomfort. The observation of three children with severe and painful herpes zoster during therapy with immunosuppressive agents prompted this review of the circumstances in which the typically mild course of this disease may be altered. (C.H.)

8869 MEGAVOLT THERAPY IN GYNECOLOGY. Kuttig, H. (Univ., Heidelberg). Arch. Gynaekol., 202: 309-12(1965). (In German).

Percutaneous ^{60}Co therapy or reduction of localized Ra doses is preferable to the usual methods of Ra treatment used for uterine carcinoma. The possibility of using percutaneous irradiation alone for closely controlled dose distribution conditions, and adapting the dose distribution pattern exactly to the varying position of the uterus, and the distribution of infiltrates or areas of lymphatic flow are extremely important for improvement in radiation protection. In cases where localized treatment with Ra is impossible, or where some clinical reasons prevent Ra treatment, percutaneous irradiation with ultrahard radiation is available. The methodology of this type of treatment has been developed enough to indicate that biaxial pendulum irradiation provides the most favorable distribution of the dose. In the area of the primary tumor the dose obtained is from 6000 to 8000 R. In 420 patients with Stage I carcinomas the 3- and 4-yr cure rates were 92 and 86%, respectively. Supervoltage therapy provides for smaller treatment risk to the patient, with optimal adaptation of the dose sequence to the diseased area, at the same time subjecting the treatment and nursing personnel to very little radiation burden. (BBB)

8870 BONE MARROW TRANSPLANTATION AFTER TOTAL-BODY IRRADIATION. Balner, H. (Univ., Amsterdam). Jaarb. Kankeronderz. Kankerbestrijding Ned., 13: 177-80(1963). (In Dutch).

The majority of lethally irradiated rats were kept alive by intravenously administered suspensions of homologous bone marrow. Mortality was variable; 20 to 40% died within the first month probably because of infectious complications. The minimum dose of homologous bone marrow was about 50×10^6 cells. Indication of a median-lethal-dose effect was not found. Secondary effects appeared in the second and third months after therapy; morbidity and mortality were variable, but averaged 30% and 15% respectively. Colitis and diarrhea were not found, possibly because the animals were specifically pathogen free. Animals under such treatment were able to accept skin transplants of the same genetic type after the administered bone marrow; the assumption of the immunological system by lymphatic cells of the donor type is thus indicated. By the seventh month degenerative processes had occurred in nearly all animals; cataract and nephrosclerosis in particular were noted, with distinctions between the two strains of rats used. (BBB)

8871 PROTECTIVE EFFECT OF ENDOTOXIN IN X-IRRADIATED MICE. Miler, I. (Inst. of Microbiology, Prague). Folia Microbiol (Prague), 11: 139-45(1966).

A partial radioprotective effect of somatic antigens of gram-negative bacteria has been previously demonstrated. Experiments were carried out in mice irradiated with lethal and midlethal doses to evaluate the optimal time relation between injection of endotoxin and irradiation, and the possibility of therapeutic use of endotoxin in postirradiation disease. In mice x irradiated with 550 or 750 R doses the protective effect of bacterial endotoxin isolated from strains of Salmonella typhi was limited to administration a short period before irradiation. Administration of endotoxin in repeated doses did not enhance protection. Injection of endotoxin 4 days after x ray treatment resulted in increase of lethality of x radiation and earlier deaths of experimental animals. Active intravenous and intraperitoneal immunization with endogenous strains of Escherichia coli isolated from the intestinal flora of mice had a demonstrable protective effect when compared with passive immunization. Nontoxic doses of endotoxin administered in the initial phase of development of radiation disease had an additive effect and lethality of the process was potentiated and markedly accelerated. This was most pronounced in mice irradiated with a midlethal dose. This shows that endotoxin is not suitable for therapeutic use in radiation disease. The possible mechanism by which endotoxin elicits partial protection against irradiation is discussed. From immunological aspects, endotoxin may enhance resistance by mechanisms involved in elimination of endogenous infection in the later stage of radiation disease. (BBB)

8872 CLINCAL ASPECTS AND THERAPY OF BONE MARROW INSUFFICIENCY. Stacher, A. (Hanusch-Krankenhaus, Vienna). Wien. Klin. Wochensch., 76: 781-5(1964). (In German.)

Bone marrow transplantation is being used increasingly to treat subjects who have undergone heavy ionizing irradiation and other conditions wherein hematopoietic function is depressed. The author describes 79 cases in which myelopathy required bone marrow transfusion; 5 of these patients had received massive doses of radiation. Most of the remaining were suffering from infectious or allergic diseases. Most patients were between the ages of 50 and 60 yr. Forty-four of the 79 cases terminated fatally, most of

them dying of infectious complications of bone marrow failure. Thirty-five are still living, at least several years after bone marrow transplantation. Eighty percent of the cases had disturbances in iron metabolism, with elevated serum Fe levels. Antibodies against blood cells could be demonstrated in 17 cases, and may have played a role in the myelopathy. (BBB)

8873 PREVENTIVE MEASURE FOR LEUKOPENIA IN ANTINEOPLASM CHEMOTHERAPY AND RADIOTHERAPY. Wakizaka, J. Bull. Soc. Int. Chir., 20: 601-3(Oct.-Dec. 1961).

A new method for the prevention of leukopenia during treatment of cancer with ionizing radiations and drugs is discussed. The proposed method called for the injection of small amounts of an 80:20 mixture of terpene oil and benzyl alcohol. The effect of a single injection of the mixture on the peripheral leucocyte count varied. About the third day after injection, the number of leucocytes gradually increased and the albumin/globulin ratio began to decrease. About the sixth day after injection, the number of leucocytes reached a maximum with a marked increase of leucocytes in the bone marrow and spleen. The increase in number of leucocytes was followed by a general decrease. Injection of a large dose was followed by a decrease in the hematocrit ratio with no change in circulating blood volume. There were no apparent changes in the colloid osmotic pressure of the blood, serum electrolytes, or renal function. Mild congestion of the liver and spleen occurred with atrophy of the germinal centers. The bactericidal activity of whole blood was increased as the mixture dose was increased. Subcutaneous injections of the mixture did not accelerate the side effects of radiation therapy. Injected irradiated animals survived for a longer period of time than those of the control group. In rats with transplants of Yoshida sarcoma, the life span was not shortened; mitosis of sarcomal cells was not increased; and the growth of malignant tumors was not accelerated. The terpene oil:benzyl alcohol mixture was thought to act as a stimulant for increased production of neutrophillin by the liver, which in turn stimulated leucocyte production in the bone marrow. The only ill effect of this procedure was that an occasional inflammatory reaction at the site of the injection ensued and became painful. (BBB)

8874 RADIONECROSIS OF THE LOWER JAW TREATED BY MULTIPLE FLAPS. Goumain, A. J. M.; Fevrier, J. C. Bordeaux Chir., 3: 143-4(July 1964). (In French).

The case of a 54-yr-old patient who had developed maxillary radionecrosis of the lower jaw following Ra, ^{60}Co, and x-ray treatment is described. Repair of the large necrotic defect in the tissue was carried out by surgery within the mouth and on the skin. The intrabuccal procedure consisted of a rotation flap obtained from the cervical-presternal area. To superficially fill the defect, a tubular flap was used. A bone graft was used to replace the mandibular defect. The successful operative procedures and the sequence in which they were used are described in detail. It was pointed out that some cases of radionecrosis develop expanding lesions and that surgery, with complete debridement of devitalized tissue, is essential to limit the extent of the lesion. The bitemporal flap grafting technic was found to be very effective for reconstructive surgery of this type. It allowed replacement of bone and assured a viable graft. The importance of a tracheotomy in cases such as this was emphasized. (BBB)

8875 TECHNICAL POSSIBILITIES OF GENERATING HIGH-ENERGY RADIATION (IN THE MEGAVOLT RANGE). Walter, E. Radiaz. Alta Energ., 3: 187-99(Oct. 1964). (In Italian).

Fundamental aspects of the generation of high-energy beams for radiotherapy, by linear and circular accelerators, are discussed with respect to technical problems and therapeutic advantages. The tissue-absorption properties of megavoltage radiation provide advantages in certain therapeutic situations which allow a maximum cancericidal dose while sparing normal tissues. The construction of modern linear accelerators, which can produce electrons at 6 to 8 MeV over short acceleration paths, and of the betatron, a circular accelerator, providing electrons up to 42 MeV, is explained. Radioprotection against high-energy beams is briefly commented on. (BBB)

8876 BODY AREA SCANNING WITH RADIOISOTOPES. Kilthau, Gustave F. Radiol. Technol., 35: 17-27(July 1963).

Fundamental aspects of the use of radioisotopes for outlining organs or lesions in organs are considered. Descriptions are given of the basic features and methods of radioisotope area scanning techniques and of the principles upon which these techniques are founded. A discussion is presented of scan contrast control including television contrast enhancement. Specific area scanning methods are pointed out and references made to the latest scanning methods, some of which are still in the experimental stages. While few direct comparisons can be made between area scanning techniques and radiography as such, it is apparent that both systems, while not directly comparable, are nonetheless similar in many outward respects and are complementary in use. So that the subject receives a minimal dose of radiation, the radioactive label and the carrier substance must be chosen with care, for tissue irradiation will not cease upon completion of the scan, but only upon the elimination of the radioisotope from the body, or upon its decay to the stable form. An organ-by-organ description of scanning technics is given. (BBB)

8877 INTRODUCTORY NOTE TO THE STUDY OF VASCULAR ALTERATIONS IN RADIODERMATITIS. Lampertico, P.; Piotti, F.; Taveggia, F. (Univ., Milan). Minerva Chir., 20: 363-8(May 15, 1965). (In Italian).

Histologic studies of skin biopsies from cases of acute and chronic radiation-induced dermatitis are described. Acute forms usually developed in one to two weeks postirradiation in the erythematous skin. Microscopic examination showed vasodilatation of the superficial blood vessels of skin along with a perivascular infiltrate of inflammatory cells. This was accompanied by hydropic degeneration of epithelial basal cells and nuclear pyknosis. In severe cases, a necrotic zone, surrounded by polymorphonuclear leukocytes, developed. In the chronic form of radiodermatitis, sclerotic-atrophic and ulceronecrotic reactions predominated. Epithelial cells often showed many abnormal mitoses. Acanthosis and hyperkeratosis, and in some cases premalignant changes, were seen in epidermis. Basal cell and spinocellular carcinomas, as well as sarcomas, were noted. Fibrosis and some degeneration of collagen fibers were noted in deeper layers of skin. Forty cases with radiodermatitis required some surgical treatment of the affected skin. The vascular changes were thought to be of fundamental importance in the loss of viability of heavily irradiated skin; these are described in detail. (BBB)

8878 LASER ENERGY: ITS TUMORICIDAL EFFECT. Nahum, Louis H. Conn. Med., 30: 22-3(Jan. 1966.)

The physical nature of laser radiation, its biological effects, and its use in treatment of cancer are briefly reveiwed. Of tumors of human origin, or autogenous hamster origin, subjected to laser energy ranging from 50 to 1500 J, half were cured. A ruby laser system, sighted through an operating ophthalmoscope, has been used for treatment of localized lesions of the eye such as retinal tears and certain tumors arising in the retina. Regression and eventual dissolution of small metastatic melanotic melanomas surgically exposed before laser therapy have been demonstrated, as well as treatment of basal-cell carcinomas, Kaposi hemorrhagic sarcomas, and cavernous hemangioma in patients with high-energy ruby laser radiation. It has been used during the course of a craniotomy for the removal of a brain tumor and the surrounding area. For cure of a lesion, it must be made accessible to the laser beams. Unless all of the cancer is removed or destroyed to the last cell and does not recur over a period of years, the treatment is not curative and is ineffective. Tumoricidal activity of laser energy depends on factors such as the absorption capability of the tumor, ratio of dose to tumor mass, and laser energy densities utilized. The mechanism of laser-energy action on certain malignant tumors is still unsolved. The thermal effects have been carefully observed, recorded, and analyzed, but the principle biologic effects of laser energy action on malignant tumors may be more than that of heat alone. Enzymes may be altered or lose their specificity. High electric fields may also cause the breaking of molecular bonds. (BBB)

8879 TREATMENT OF BASAL CELL EPITHELIOMA BY LASER RADIATION. Goldman, Leon; Wilson, Robert G. (Children's Hospital Research Foundation, Cincinnati). J. Amer. Med. Ass., 189: 773-5(Sept. 7, 1964).

Histologic studies are reported on the effect of laser radiation on human tumor cells. Selected for intensive laser irradiation was a nonpigmented basal cell malignancy on the forearm; this nodular type of basal cell epithelioma had an erythematous base. The nodular portion measured 0.75 by 1.25 cm and was elevated above the skin for 1.0 cm. The pearly grey nodular area was impacted four times with a pulsed ruby laser, unfocused, with an energy density 100 J/cm^2. The target area was 0.9 cm^2. The impacts were not painful and there was very minimal bleeding. Within 15 min after impact, a deep red erythema spread beyond the confines of the impact area and subsided only after eight days. Twenty-four days after the healed lesion was smaller and less elevated, but basal cell activity persisted. Biopsy at this time showed areas of necrosis and scarring and nests of basal cell malignancy. Biopsy at 101 days showed complete destruction of the lesion. No significant epidermal or vascular changes were noted to suggest precancerous changes in the skin or thrombosis of blood vessels. However, long periods of observation are still required to determine the late effects of laser irradiation in man. Cytological experiments with fresh tissue from cystic or extrusion types of basal cell epithelioma in single cell layer sheets showed no effect of laser radiation at energy densities of 100 J/cm^2. Material stained in situ

with 1% Evans blue and 10% copper sulfate solution and impacted with 100 J/cm^2 energy density, target area 0.005 cm^2, showed extensive destruction. Pigment in tissue has some selective effect in absorption of laser irradiation, so that a nonpigmented mass requires greater energy density. (BBB)

8880 MILITARY MEDICAL ASPECTS OF LASERS. Glew, Donald H. Jr. (George Washington Univ., Washington, D. C.). Milit. Med., 131: 499-504(June 1966).

Of immediate concern to military medical advisors engaged in the development of laser range finders and kindred devices are the inherent hazards of laser light in producing unconventional damage as well as the ordinary hazards of high-voltage equipment. As a point of reference regarding ocular hazards, with the pulsed ruby laser (6943 Å), a permanent detectable lesion (a threshold lesion) can be produced by 0.85 J/cm^2 delivered in 200 μsec or by 0.07 J/cm^2 on the retina for 30 μsec. The U. S. Army Medical Research and Development Command has sponsored a program in laser biology to define both immediate and potential long-term hazards of laser radiation and to discover and explore the fundamental mechanisms involved. This program is described. The work has been primarily aimed at providing full information on laser hazards and obtaining precise data convertible to field tables or nomograms for use by field commanders and users. The laser biological effects research program has also been directed to obtaining a full understanding of biological mechanisms and phenomena involved in laser interaction with living tissue and organic matter. Medical and biological research uses of laser radiation are also described. When optically focused, a laser beam can be narrowed to a point of high energy density which cuts continuously through tissue, depending upon the amount of energy in the beam and how rapidly the beam passes over the tissue. No bleeding is noted from the cut edge and damage to adjacent tissue is minimal. While various incisions, including laparotomy, can be satisfactorily made, an even more important finding may well be in the intra-abdominal application of the focused laser beam, where, for example, in rabbits, precise, relatively rapid, and bloodless excision of large portions of liver without damage to adjacent structures can be performed. (BBB)

8881 LASERS AND THEIR NEUROSURGICAL APPLICATION. Fix, John L. (Veterans Administration Hospital, Washington, D. C.); Stein, Marvin; Hayes, Jude R. Milit. Med., 131: 493-8 (June 1966).

The use of laser radiation in neurological surgery is evaluated from two aspects: The dangers or side effects of interaction between laser energy and the central or peripheral nervous system and the biologic application of laser energy to improve diagnosis and treatment in clinical neurosurgery. It was demonstrated that a single 50- to 100-J pulse of red ruby laser radiation delivered to the intact, exposed skull of a guinea pig was immediately lethal due to an internal explosion phenomenon within the intracranial cavity. When 20 to 30 J were used, death due to brain swelling and hematoma was delayed several hours. However, the laser beam cannot be used as a means of selectively destroying nuclear centers or neural pathways stereotaxically as can be done by the proton beam. The latter method leaves the intervening brain intact, but for use of laser radiation in the same manner, not only would tremendous amounts of energy be needed in order for the deep-seated target to be destroyed but also all the intervening tissues would be destroyed along the path of the beam. Hence from a practical point of view this method is not feasible, and from a safety point of view this method runs the risk of converting tissue (especially water) into gas (mainly steam) inside the skull, thus rapidly increasing intracranial pressure to lethal levels. Present-day laser equipment has sufficient energy and power to kill a guinea pig in this way but not a human being. The skull thickness of a guinea pig is only about one-half to one mm and allows transmission of only about 10% of the incident energy. Attempts were made to coagulate blood vessels with the pulsed ruby laser. At low energies the vessels could not be penetrated with sufficient energy to coagulate the contained blood, and at higher energies the vessels usually ruptured due to over-pressures rapidly created. Hence the use of this tool to coagulate vessels or aneurysms is not feasible. (BBB)

8882 USE OF RADIOCOLLOIDS IN OVARIAN CARCINOMA IN PREVENTION OF POST-SURGICAL RECURRENCE. Goldstein, A. M. (Christchurch Hospital, New Zealand). J. Coll. Radiol. Austral., 9: 284-9(Oct. 1965).

Use of ^{198}Au and ^{90}Y to treat 39 cases were reported along with a description of the technique, clinical results, and complications. Although its most penetrating β radiation has a range of 3.8 mm in tissue, the half value range in tissue is only 0.265 mm, and the latter is regarded as the effectively treated thickness of tissue. Radiogold also emits γ rays of 0.412 Mev energy. These are relatively low in intensity and contribute only 10% of the total radiation dose delivered to the 0.265 mm of tissue in contact with the colloid. The emission of γ rays nevertheless leads to protection problems in transport, handling, and administration of the material and increases the integral dose of radiation received by the patient without significantly increasing the dose to the target tissues. The average dose received by 28 surviving patients was 108 mC and by 10 deceased patients was 120 mC. The estimated surface dose to the peritoneum from 150 mC of radiogold is 4500 rad in 10 to 12 days. The limited effective range in tissue of the radiation emitted by radiogold led to the search for a more suitable radiocolloid. This included ^{90}Y, a pure β emitter, with a half-life of 2.68 days, a max β-ray energy of 2.26 Mev, and a mean β-ray energy of 0.90 Mev. The maximum β range in tissue is 10.5 mm, its half value range in tissue is 0.98 mm, and the effective radiation dose is confined to this tissue depth. Thus the thickness of tissue irradiated effectively is three times greater than that by radiogold. The surface radiation dose rate per mC is nearly three times greater than that of radiogold, and doses of the order of 50 mC are well tolerated and give good results in the palliation of effusions. Advantages of radioyttrium include simplicity and safety of transport, handling and administration, and the lack of γ emission likewise reduces the integral dose to the patient and simplifies nursing care. (TSS)

8883 SUNLIGHT PROTECTION IN NORMAL SKIN BY ABSORPTIVE FILTER CHEMICALLY INDUCED BY STRATUM CORNEUM. Fusaro, Ramon M.; Runge, Walter J.; Lynch, Francis W.; Watson, C. J. (Univ. of Minnesota Hospital, Minneapolis). Arch. Dermatol., 93: 106-11(Jan. 1966).

Chemical treatment of the skin was carried out to produce an intradermal compound which absorbed uv light. Dihydroxyacetone (DHA) and 2-hydroxy-1,4-naphthoquinone (Lawsone) were used. The uv-protective effect of the sunscreen filter chemically induced in normal skin was tested by using direct sunlight exposure to assure effectiveness. The topical preparation was applied immediately after mixing. Washing with soap and water did not remove the protective filter. Greater protection from uv light resulted from repetitive use or increase of the applied quantity, or both. Separate application of either component of the mixture produced no significant protection against uv in clinical trials and in vitro experiments. Under the conditions of chemical analysis the two components DHA and Lawsone were recovered quantitatively. At room temperature the mixture can deteriorate within one to several days as a function of temperature. If used immediately after mixing, it was found to be effective in inducing a sunscreen filter into the skin; therefore, to avoid any possibility of chemical decomposition, the two compounds were prepared separately and mixed just before use. (BBB)

8884 LATE CNS SEQUELAE OF X IRRADIATION. Nastev, G.; Ovcharova, P. (Inst. for Postgraduate Medical Education, Sofia). Suvremenna Med., 16: 391-9(1965). (In Bulgarian).

The literature of late effects of radiation on the central nervous system is reviewed. Neurologic disorders are reported in five patients who had received radiotherapy for: nasal polyps, facial paralysis, or breast cancer. (TSS)

8885 EFFECTS OF HORMONES ON THE LIFE SPAN OF IRRADIATED RATS. Vlasenko, S. P.; Garibyan, D. Kh.; Shakhnazaryan, E. L. (Div. of Radiobiology, Academy of Medical Sciences, USSR). Biol. Zh. Arm., 19: No. 7, 21-6(July 1966). (In Russian).

Daily treatments with adrenalin prolonged the life span and stimulated respiration in rats suffering from radiation sickness. Daily treatments with adrenocorticotropic hormone or cortisone produced adverse effects on respiration and shortened the life span of the sick animals. Treatment with insulin did not produce any appreciable influence on the condition of the sick animals. (tr-auth)

8886 NEW SIMPLIFIED SYSTEM OF DOSAGE IN RADIOTHERAPY. BIODOSE FACTORS AND CURVES. Bistolfi, Franco. J. Belge Radiol., 49: 206-27(1966). (In French).

All the published time-dose curves may be considered, at any of their points, as percentual values of corresponding points found on the erytheme curve of Strandquist, this being also of value for other time-dose curves traced by the author and based on dosage data from recent works. Thus, the erytheme curve of Strandquist may be considered as a unity of measure in the biological dosage system, in such a way that the different couples of dose time values representing it (or erytheme chronodose value E.C.D.) become in fact biodose unities. The author calculated a great number of biodose factors; these calculations may be considered as the base of a system of dose calculation for the radiotherapy of tumors. This system greatly simplifies dose calculation, so that the study of time-dose curves, with its rather complex calculations, is no longer necessary, at least in practice of radiotherapy. It is sufficient to use only small figures (biodose factors ranging from 0.20

to 3) which, from the statistic point of view, allows the selection of the necessary dose for the destruction of the tumor without damage to the surrounding healthy tissue. The biodose factors, applied to the isodose curves, allow a simultaneous study of the factors "time" and "space" within an extremely interesting radiological and clinical system, represented in practice by the biodose curves. The biodose factors predominate on the dose time curves only in clinical practice, whereas the last remain essential for quantitative study of the relation dose/effect on a not yet examined target-tissue. (TSS)

8887 RADIOPROTECTIVE EFFECT OF CHOLINEMIMETICS. Staib, A. H.; Effler, K. (Carl Gustav Carus Medizinische Akademie, Dresden). Naturwissenschaften, 53: 583(Nov. 1966). (In German).

The radioprotective effect of the cholinemimetics arecoline tremorine, and oxotremorine was investigated on albino male exposed to 890 and 610 R. The results showed that pretreatment with the cholinemimetics offered a significant radioprotective effect against both lethal and sublethal doses. (J.S.R.)

8888 REEVALUATION OF ^{131}I-THYROID UPTAKE RATE IN EUTHYROID AND VARIOUS THYROID DISORDERS. Kinoshita, Fumio; Yasuda, Mitsuya; Maekawa, Akira; Hichiri, Yasushi; Yamagishi, Ichiro (Okubo Municipal Hospital, Tokyo). Radioisotopes (Tokyo), 15: 359-70(Nov. 1966). (In Japanese).

Results are reported from measurements of ^{131}I thyroid uptake rate in 400 cases of euthyroid and 300 cases of hyperthyroid, 20 cases of hypothyroid, 230 cases of non-toxic diffuse goiter, 140 cases of non-toxic nodular goiter, 30 cases of malignant goiter, 20 cases of subacute thyroiditis, and 50 cases of chronic thyroiditis. In 400 cases of euthyroid and 300 cases of hyperthyroidism, no significant differences of ^{131}I thyroid uptake rate was seen depending on the sex and age of the subjects. Lower 24 hour uptake than 3 or 6 hour uptake was seen in 7.3% of euthyroid cases, 30.0% of hyperthyroid cases, 7.9% of cases of non-toxic diffuse goiter, and 5.5% of cases of non-toxic nondular goiter. When 20% was used as the upper limit of normal for 3 hr uptake value, the diagnostic error was 2.8%; when 35%, and 45% were used as the upper limits for 6 and 24 hr uptake respectively, the respective diagnostic errors were 1.8 and 2.4%. In 150 cases of hyperthyroidism successfully treated with ^{131}I, ^{131}I thyroid uptake after treatment was 1.4 to 70.9 (average 29.2% to 39%) and 15.3% of the cases showed ^{131}I thyroid uptake rate higher than 40% or lower than 10% respectively (70 references). (auth)

8889 RADIOTHERAPY OF CANCER WITH NEGATIVE PI MESONS. Horst, W.; Conrad, B. (Univ., Zurich). Fortschr. Geb. Roentgenstr. Nuklearmed., 105: 299-321(Sept. 1966). (In German).

The curative results in the treatment of malignant disease, defined as five year cures, are due equally to surgery and radiotherapy. By means of high voltage therapy, using the betatron or radiocobalt, it is possible to treat any lesion at any depth with an optimal dose. Tumor dose is no longer governed by physical or technical considerations, but depends on the tolerance of the normal tissues in the vicinity of the tumor. The aim of radiotherapy is to increase the destructive effect of the rays on the tumor without, at the same time, increasing the damage done to normal tissues. According to modern views, about one per cent of cells in a malignant tumor is anoxic. Anoxic cells are resistant to conventional radiation (x rays, betatron, ^{60}Co). Not infrequently they survive a course of radiotherapy and thereby represent a residual tumor that may give rise to a recurrence. Radiation causing dense ionization, such as fast neutrons and the nuclear fragments produced by the entry of negative pions into tissues have a markedly more lethal effect on anoxic cells. The gain produced by the increased destructive effect on anoxic malignant cells must be balanced against a reduced ability of normal tissues to recover following this type of radiation, but this may possibly be compensated by changes in the dosage schedule. The dose distribution of a pion beam in the organism and its suitability for various therapeutic problems is better than that of any conventional type of radiation. The proton-isochronocyclotron in Zurich producing five hundred MeV at 100 μA current will be able to deliver a beam of negative pi mesons of sufficient intensity for the treatment of patients. (auth)

8890 AN EPIDEMIOLOGIC APPROACH TO LOW-LEVEL ^{226}Ra EXPOSURE. Petersen, Norman J. (Communicable Disease Center, Phoenix, Ariz.); Samuels, Larry D.; Lucas, Henry F.; Abrahams, Simon P. Public Health Rep. (U. S.), 81: 805-14(Sept. 1966).

An epidemiologic investigation of human populations exposed to elevated levels of radium-226 in drinking water identified 111 Iowa and Illinois communities, with a combined population of almost 1 million people, exposed to a mean drinking water concentration of 4.7 pCi radium-226 per liter during 1950-62. Based on a retrospective analysis of data from death certificates, this population group exhibited an adjusted bone neoplasm mortality rate of 1.41 deaths per 100,000 compared with a rate of 1.14 in a control population (P = 0.08). An intermediate rate of 1.25 was exhibited by the populations in downstate Illinois and Iowa, which were not included in either study group but exposed to an estimated radium 226 concentration higher than that in the control communities and lower than that in the exposed communities. The difference between the rates in the exposed and control groups was more significant in the population under 30 years of age than in the group 30 years and over. Some significant differences were noted between the bone neoplasm mortality rates of population groups with no apparent difference in radium 226 exposure. A comparison of adjusted mortality rates from all causes of death in exposed and control communities with populations of more than 10,000 revealed no significance difference. However, the mortality rates in the exposed groups aged 0-9 and 30-39 years were significantly higher than in the control groups of these ages. This finding deserves further investigation with respect to the causes of death responsible for the apparent excess in mortality and the consistency of this difference in communities with populations of less than 10,000. (TSS)

8891 HEMOPOIETIC RECOVERY FOLLOWING ACUTE RADIATION DISEASE WITH COMBINED ADMINISTRATION OF CYSTAMINE, AMIDINE, AND HOMOLOGOUS BONE MARROW. Zografov, D. G.; Baev, I. A.; Bonev, L. E.; Robev, St. K. (Scientific Research Inst. for Radiology and Radiation Hygiene, Sofia). Rentgenol. Radiol., 4: No. 2, 119-27(1965). (In Bulgarian).

Rats received 100 mg/kg of cystamine and 150 mg/kg of N-(4-nitrophenyl)benzamidine interperitoneally 8 minutes before 735 R irradiation and homologous bone marrow transplantation 22 to 24 hours after irradiation. Of the four groups (control, drug, transplantation and drug plus transplantation), the last group was by far the best as evaluated from ^{59}Fe 24-hour uptake by erythrocytes. (auth)

8892 CONSIDERATION OF NONUNIFORMITY OF TISSUES IN THE COMPILATION OF ISODOSE CHARTS. Zholkiver, K. I.; Zevrieva, I. F. Med. Radiol., 11: No. 8, 14-19(Aug. 1966). (In Ukrainian).

The authors elaborated a technique for the compilation of isodose charts reflecting the spacial distribution of the dose with special consideration of the nonuniformity of irradiated tissues and the presence of a clearance between the draw-tube and the surface of irradiation. The method is based on the isodose curves obtained in a homogenous medium, with calculated correction coefficients for the pulmonary tissue, depending upon the value of the clearance, density and thickness of the bone. These corrections, expressed in a percentage decrease or increase of the nominal dose, are given for radiations of diverse quality and for different irradiation fields. The utilization of corrections for the nominal doses enables the compilation of more precise charts of isodoses, this being necessary for the correct planning of radium therapy. (auth)

8893 PRESENT STATUS OF BONE MARROW TRANSPLANTATION FOLLOWING WHOLE BODY IRRADIATION. Van Bekkum, D. W. (Radiobiological Inst. TNO. Rijswijk, Netherlands). Oncologia, 20: Suppl., 60-72(1966).

The use of monkeys as experimental animals in the study of factors that prevent the successful clinical application of bone marrow transplantation is described. The finding that preservation of monkey bone marrow with the current techniques of freezing causes a severe loss of viable cells has provided an explanation of the disappointing results obtained with frozen autologous bone marrow in patients. An improved method of preservation was developed, which is recommended for clinical trials. The acute secondary disease that regularly follows the transplantation of homologous bone marrow in primates, was successfully controlled in monkeys by the early administration of the cytostatic agents amethopterin and cyclophosphamide. The effective time of administration of these drugs was derived from the results obtained with a model system employing mice. The implications of this finding for the eventual clinical use of homologous bone marrow are discussed. (auth)

8894 OXYGEN EFFECT IN RADIOTHERAPY. Churchill-Davidson, I. (St. Thomas' Hospital, London). Oncologia, 20: Suppl., 18-29(1966).

Experiences following the irradiation of 235 patients under conditions of high-pressure oxygen are reported. Only persons for whom cure by conventional radiotherapy was hopeless were chosen. All patients were given a max tissue dose of 3500 to 3750 rads ^{60}Co γ rays in 6 treatments over 18 or 19 days. Especially good results were obtained with tumors of the mouth, tonsil, nasopharynx, larynx, and uterine cervix. Radionecrosis of laryngeal cartilage was the one serious complication. (H.G.D.)

8895 NOMOGRAMS FOR THE ELABORATION OF ISODOSE CHARTS IN THE USE OF GAMMA-THERAPEUTIC APPARATUS. Galina, L. S. Med. Radiol., 11: No. 8, 8-14(Aug. 1966). (In Russian).

Basing upon an analysis of isodose distribution the author derived nomograms for the assessment of isodoses of any square in the SSD (source-Skindistance) averaging 75 cm. With due consideration of the corrections made these nomograms may be employed for the elaboration of isodose charts of square and rectangular fields in SSD amounting from 35 to 75 cm. (auth)

8896 DISTRIBUTION OF ABSORBED RADIATION DOSES IN THE ORGANISM CONSEQUENT TO WHOLE-BODY RADON BATHS. Andreev, S. V. Med. Radiol., 11: No. 8, 55-63(Aug. 1966). (In Russian).

By means of experimental investigations the author studied the distribution of radon, Ra A, Ra B and Ra C in the organism following whole-body radon baths, and determined the absorbed radiation doses for 14 organs and tissues of albino rat and man. On the basis of these data the author proposes simple formulas which help to calculate analogous doses for different techniques in this form of alpha-therapy. (auth)

8897 TRITIATED THYMIDINE AS A CYTOCIDAL AGENT IN HUMAN LEUKEMIA. Greenberg, Michael L. (Brookhaven National Lab., Upton, N. Y. Mount Sinai Hospital, New York); Chanana, Arjun D.; Cronkite, Eugene P.; Schiffer, Lewis M.; Stryckmans, Pierre A. Blood, 28: 851-9(Dec. 1966).

Two patients with acute leukemia had considerable decreases in leukemic cells in the peripheral blood as well as reduction in size of spleen and leukemic masses after 10 injections of ^{3}H-TDR given over a 5-day period. Each injection was 0.25 μc/Gm body weight. The pertinent aspects of cytotoxic effects of ^{3}H-TDR are reviewed. The radiation doses delivered to the nucleus are estimated from autoradiographic data. Evidence is presented for the observed effects being due to ^{3}H-TDR. (auth)

8898 RADIATION EXPOSURES TO THE EXAMINEES DURING ROENTGENODIAGNOSTIC INVESTIGATIONS AND CRITERIA OF PERMISSIBLE DOSES. Krongauz, A. N.; Gorelova, L. N.; Gotlib, V. Ya. Med. Radiol., 11: No. 8, 77-84(Aug. 1966). (In Russian).

The utilization of x ray radiation during mass prophylactic examinations of the population, as well as in roentgenodiagnostic investigations, require assessment and restriction of radiation exposure to the examinees. The principal indices of radiation exposures are the dose in the region of gonads and the integral absorbed dose in the body. The authors propose criteria of permissible irradiation doses for examinees during x ray investigations for prophylactic purposes and clinical indications. As a maximal permissible level of annual irradiation in prophylactic investigations the natural background is recommended, whereas in clinical investigations for persons aged up to 50 years the level of occupational irradiation is advocated. For persons over 50 years old and in an established oncological diagnosis, or during examination of patients suspected of an oncological disease, as well as in instances when there are vital indications, the maxima permissible doses are not set down. (auth)

8899 ALTERATION OF THE "HALF-DOSE LAYER" IN SHORT-FOCUS X RAY THERAPY. Ruderman, A. I.; Stavitskii, R. V. Med. Radiol., 11: No. 8, 3-8(Aug. 1966). (In Russian).

Under discussion are the values of the "half-dose layer" of radiation (3.5, 9.0 and 12 mm) as standard for all possible surface localizations subjected to short-focus roentgen therapy. The authors propose a technique of determining the regimen of work of the x ray tube for ensuring the necessary values of the "half-dose layer" of radiation. On the basis of experimental research the authors obtained a table of optimal conditions for the formation of the x ray radiation beam for the PYM-7 apparatus. (auth)

8900 THE INTEGRAL DOSES CREATED BY ^{133}Xe IN INTRAVENOUS ADMINISTRATION. Kalantarov, K. D.; Varentsov, Yu. M.; Lyass, F. M. Med. Radiol., 11: No. 8, 19-24(Aug. 1966). (In Russian).

The administration of large quantities of ^{133}Xe (up to 20 mc in intravenous introduction) creates in the organism a dose of irradiation of ~4 mrad (320 rad), this is tens of times less than the doses sustained by the patient in any method of x ray diagnosis. The importance of introduction of large activities of ^{133}Xe makes it possible to obtain statistically significant information on rapid processes in the organism, as well as to carry out repeated diagnostic tests after different time lapses. The feasibility of repeated administrations enables to conduct diagnosis in functional loadings, this augmenting the value of the information, as well as to control the functional restoration of individual organs in the process of treatment. (auth)

8901 INFLUENCE OF CERTAIN HETEROCYCLIC COMPOUNDS, INCLUDING RADIOPROTECTORS, ON OXYGEN CONSUMPTION IN DIFFERENT TISSUES. Benabid, Yvette; Rinaldi, Renaud (Centre d'Etudes Nucleaires, Grenoble, France). Compt. Rend., Ser. D, 263: 683-6(Aug. 22, 1966). (In French).

The influence of certain compounds on oxygen consumption in the liver, kidney, spleen, brain, muscle, and erythrocytes of mice was studied. Compounds used were cysteine, cysteamine, imidazole, benzimidazole, naphthyl-methyl-imidazoline, privine, otrivine, mercapto-imidazole, regitin, and antistine. Results of the study demonstrated that these substances affected oxygen consumption in brain tissue only. It was shown that nitrogenous heterocyclic compounds of the imidazole series diminish the effect of radiation without reducing the oxygen consumption of tissues. It seemed evident that hypoxia was not responsible for the radioprotective action of these substances. (H.L.W.)

8902 ROENTGENOLOGIC PULMONARY CHANGES CAUSED BY RARE EARTHS. PRELIMINARY REPORT. Hoschek, Rudolf. Zentralbl. Arbeitsmed. Arbeitsschutz, 14: 281-4(Dec. 1964). (In German).

Alterations in the x-ray pictures of the lungs which resembled silicosis in stages I or II were observed in several workers engaged in retouching in the offset-copy department of a printing plant. These workers had inhaled fumes from an arc lamp for several decades. The intensity of the lung changes observed varied with the duration of exposure to the lamps. In this operation 40 to 50 offset copies were prepared daily. This is ~10 times as many as is usual in this type of operation. The film shadowing observed was found to be due to deposition of rare earth dust that had been added to the raw metal of the arc lamp to increase its intensity. It was surprising that there had been no disturbance of pulmonary function, and no poisonous effects from resorption of the material had been observed. The effects appeared to be similar to those observed in barytosis and siderosis, with a nonreactive deposition of the rare earth dust. This produced a high-contrast picture of the lungs because of its high atomic number, without inducing any ill effects. These results were similar to those found in experimental animals, which indicated that fibrous or granulomatous tissue reactions cannot be expected in humans. The least amount of Th possible should be used in manufacture of arc lamp carbons. (BBB)

8903 THE SCIENTIFIC BASES FOR THE GASTEIN CURE. Scheminzky, F. (Institut fuer Balneologie, Innsbruck). Wien. Klin. Wochensch., 77: 533-7(Aug. 6, 1965). (In German).

The concentration of Rn is approximately 20 nCi/l in the thermal baths at Gastein. The retention of the gas in the body is very short, since it has a biological half time of only 10 to 20 min. Studies have indicated that the total radiation exposure during a complete course of treatment is equivalent to only 1/30 of the spontaneous mutation probability in Drosophila. The alleged favorable biological effects of the dissolved Rn is said to be due to the generalized stimulation of cell activity produced. Endocrine gland activities are also said to be stimulated. Consolidation of the tissues and improvement of circulation have also been observed as additional effects. Reports from experimental studies have tended to substantiate the beneficial effects ascribed to treatment with the radioactive waters at Gastein. (BBB)

8904 MALIGN GENITAL TUMORS AFTER RADIATION THERAPY OF BENIGN GYNECOLOGICAL DISEASES. Baessler, F.-J. Leipzig, Univ., 1965. 54p. $2.00 Gmelin, AED-Diss. 65-354.

Thesis.

Between 1945 and 1960, 1360 female patients were irradiated for castration purposes. Malign tumors occurred in only 8 patients. It is concluded that there is no indication of causal relations between malign tumor incidence and gynecological therapy. (auth)

Radiation Effects on Animals

Refer also to abstracts 8476, 8667, 8681, 8685, 8773, 8845, 8850, 8865, 8890, 8893, and 9005.

8905 (AD-631189) MEDIAN LETHAL DOSE (LD-50/60) STUDIES IN SHEEP FOLLOWING 250-kvp X-IRRADIATION. Technical Report, August 1961-May 1963. Mobley, Thomas S.; Godden, William R.; deBoer, Jelle (Air Force Weapons Lab., Kirtland AFB, N. Mex.). Mar. 1966. 29p. (AFWL-TR-65-200). CFSTI $2.00 cy, $0.50 mn.

Seventy-four sheep were subjected to bilateral, total-body, 250-kvp x irradiation at a dose rate of 7.5 R/min. Doses ranging from 218 to 518 R (midline air dose) were administered at nine different dose levels. Probit analysis of the mortality data revealed a 50-

percent, 60-day (LD 50/60) lethal dose value of 389 R with 95-percent confidence limits of from 334 R to 437 R. Converting midline air dose to midline tissue dose resulted in the value 245 R with limits of from 210 R to 275 R. All deaths occurred between 16 and 32 days following irradiation. Hematological studies and gross necropsies confirmed the severe involvement of the hematopoietic system. (auth)

8906 (AD-633203) VIABILITY OF ADULT RAT SKIN FOLLOWING .13 MeV PROTON IRRADIATION. Caraway, Bobby Lamar (Texas Agricultural and Mechanical Univ., College Station). Jan. 1966. Contract AF 33(608)-1284. 96p. CFSTI $3.00 cy, $0.75 mn.

Thesis.

The effects of low energy (13 MeV) protons upon adult rat skin were studied. The study was conducted in three parts. A pathologic study was conducted in which the carcinogenesis of proton irradiation was determined eight months postirradiation. Thirteen groups of ten rats each, which were irradiated at progressively increasing doses per group (at increments of 100 rad per group) were examined in order that a dose-pathology relationship might be established. A series of pilot experiments were performed to develop a cell culture technique conducive to growth of adult skin cells and to differentiate between the behavior in culture of irradiated cells as opposed to the behavior of nonirradiated cells. A series of experiments were conducted using cells in culture as a method to detect the point in time postirradiation in which irradiated skin cells become carcinomatous. The conclusions from this limited study point out that cell culture techniques may offer a method to detect developing carcinoma cells before neoplastic lesions actually become observable. (TAB)

8907 (AD-635559) EFFECT OF WHOLE BODY X-IRRADIATION ON HEMOLYMPH PROTEINS OF LIMULUS POLYPHEMUS. Rodkey, F. Lee; Niaussat, Pierre-Marie; Mackenzie, Maxime (Naval Medical Research Inst., Bethesda, Md.). Apr. 1, 1965. 11p. (NAVMED-MR-005.02-0011.01-7) CFSTI $1.00 cy, $0.50 mn.

Hemolymph of the "horseshoe crab" Limulus polyphemus was studied by ultracentrifugation and paper electrophoresis. Immature and mature specimens of this species were subjected to whole body x-irradiation up to 60,000 R in a single dose. The number of components in the hemolymph and their sedimentation constants were estimated by ultracentrifugation. No consistent difference was found between the whole hemolymph of control and irradiated specimens. Separation of components by paper electrophoresis likewise did not show a consistent difference between hemolymph of control and irradiated animals. (auth)

8908 (AD-635754) MEASUREMENT OF THE ANTIBODY RESPONSE BY THE ELIMINATION OF ^{131}I-LABELED PROTEINS. I. THE ELIMINATION OF ^{131}I-LABELED PROTEINS FROM THE BLOOD OF NORMAL MICE. Weyzen, W. W. H.; Silverman, M. S. (Naval Radiological Defense Lab., San Francisco, Calif.). May 19, 1966. 49p. (USNRDL-TR-1020; NAVMED-MR-005.08-1200-4). CFSTI $4.00 cy, $0.50 mn.

The effect of a number of variables on the elimination of ^{131}I-labeled proteins from the blood of normal mice was studied. The purpose of these studies was to arrive at a critical evaluation of the antigen elimination technique which will be used for the measurement of the immune response in studies on the recovery from radiation injury. The method is based on the fact that the biological half-life of a protein is reduced in the presence of specific antibodies in the blood. It was found that the elimination of ^{131}I-horse serum albumin in normal LAFl mice under the experimental conditions employed, was not affected by the amount of protein injected or by the time of sampling. Although the degree of labeling had no effect on the half-life measured, a shift of the elimination curve was observed which was time dependent. This change was attributed to radiation damage of the protein by the radioactive label. The elimination characteristics of a number of different proteins for possible use in the immunization experiments were studied. Considerable differences were observed in the way closely related proteins were eliminated from the blood. The half-life of the albumins ranged from 13.36 hours for ^{131}I-porcine serum albumin to 22.03 hours for ^{131}I-dog serum albumin. (auth)

8909 (AD-640316) RESPONSE OF ERYTHROPOIETIC STEM CELLS OF MICE TO IRRADIATION WITH FISSION NEUTRONS. Krebs, J. S. (Naval Radiological Defense Lab., San Francisco, Calif.). Aug. 19, 1966. 23p. (USNRDL-TR-1059). CFSTI $1.00 cy, $0.50 mn.

The destruction of erythropoietic stem cells of the bone marrow by irradiation with fission neutrons was studied in plethoric C57 male mice by measuring the incorporation of ^{59}Fe into erythrocytes 48 hours after a dose of erythropoietin. The survival of stem cells in mice exposed to single or repeated doses of neutrons at 37 rad/min or 1.75 rad/min followed the single-hit multi-target model of radiation injury to cells. The data strongly imply that the loss of stem cells follows the multi-target model, but that the number of targets per cell, instead of being a constant, is a basic biological variable of the response. (C.H.)

8910 (COO-78-142, pp 120–37) RADIATION CYTOLOGY SECTION. (Western Reserve Univ., Cleveland, Ohio. School of Medicine).

Progress is reported on studies on the effects of γ or uv radiation on mitosis in sea urchin eggs; the synthesis of cytoplasmic DNA in sea urchin eggs; the mechanisms of recovery from radiation damage, as measured by the incorporation of ^{3}H-thymidine in nuclear or cytoplasmic DNA; and the synthesis of protein during recovery of irradiated sea urchin eggs, in which ^{3}H-leucine was used as a tracer. (C.H.)

8911 (NYO-2778-4) EFFECTS OF H^{3}THYMIDINE AS A DNA LABEL IN THE RAT LIVER. Progress Report, September 1, 1963–September 1, 1966. Post, Joseph (New York Univ., N. Y. Medical Center). Contract AT(30-1)-2778. 17p. Dep. mn. CFSTI $1.00 cy, $0.50 mn.

Progress is reported on studies of the biological effects of radiation, problems in normal and tumor cell proliferation, and the effects of antimetabolites thereon. A series of experiments on the replication patterns of hepatocytes during the life of the rat revealed that there is an exponential decline in the percentages of cells engaged in multiplication and mitosis from birth (16%) to maturity. Thereafter cell multiplication occurs at a rate less than 0.2%. (I) In studies conducted on the replication kinetics of hepatocytes in 3-week-old Wistar rats, a regular, polycyclical rhythm of replication of tritiated-thymidine-labeled (^{3}HTDR) cohort cells was observed after 1 uCi/g whereas following 2 and 10 uCi/g the pattern was disorganized. (II) Delayed effects were examined in hepatocytes, spleen and ilial cells of rats given various doses of ^{3}HTDR. Data on hepatocytes show that the generation time was doubled from 21.5 hrs at 3 weeks to about 47 hrs after 2 uCi and about 44 hrs after 10 uCi. Differences in delayed effects in ilial cells and hepatocytes are discussed. (III) Preliminary results of a comparison of effects of administered ^{3}HTDR (10 uCi/g) upon the replication of ilial and spleen cells and coexistent carcinogen-induced autochthonous breast tumor cells demonstrate a greater effect of the ^{3}HTDR upon the replication cycle of ilial cells than that of the relatively-slowly multiplying tumor cells. (IV) When 1 uCi/g ^{3}HIUDR was given to 3-week-old rats the ilial generation cycle curve was markedly altered so as to resemble that of ilial cells after 10 uCi/g ^{3}HTDR. Hence IUDR appears to be radiomimetic. (H.G.D.)

8912 (NYO-3554-3) EFFECTS OF RADIATION ON MIGRATORY ORIENTATION OF SALAMANDERS. Progress Report, May 1, 1966–November 15, 1966. Shoop, C. Robert (Wellesley Coll., Mass. Dept. of Biological Sciences). Dec. 1, 1966. Contract AT(30-1)-3554. 9p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Preliminary results are reported from a study of the effects of doses of x radiation ranging from 40 to 1200 R on the orienting ability of migrating salamanders, Ambystoma maculatum. Animals exposed to 800 R or more died. Changes in activity and feeding behavior were noted in the most heavily irradiated animals long before visible signs of radiation injury were apparent. Field studies on the migratory orienting abilities of salamanders and population ecology studies were continued and preliminary results are reported. (C.H.)

8913 (ORNL-3999, pp 99-111) MAMMALIAN RECOVERY. (Oak Ridge National Lab., Tenn.).

Progress is reported on the following studies: experimental design approach to control of mortality from secondary disease in radiation chimeras; alteration in rate of recovery of hemopoietic cells of the bone marrow by increased pressure for erythroid differentiation; parasites in the alimentary tract of radiation chimeras; effects of whole-body x irradiation on the thymus; effect of radiation temperature on radiosensitivity of mouse bone marrow cells; effects of highly polymerized heterologous DNA on 30-day survival of lethally irradiated mice; modification of poor-growth phenomenon; abolition of poor growth of parental marrow cells in old radiation chimeras; histologic studies on poor growth of parental bone marrow; studies on a highly lethal enteric disease of cottontail rabbits. (H.L.W.)

8914 (ORNL-3999, pp 112-24) PATHOLOGY AND PHYSIOLOGY. (Oak Ridge National Lab., Tenn.).

Progress is reported on the following studies: continuing mammalian studies with 60-MeV protons in the Oak Ridge Isochronous cyclotron; influence of age at irradiation on susceptibility to radiation-induced life shortening in RF mice; polyarteritis in aging RF mice; life cycle of megakaryocytes; viability of IRC 741 leukemia cells after storage in liquid nitrogen; ability of rat bone

marrow to produce spleen colonies in irradiated hosts; preliminary observations on aging in irradiated and unirradiated germfree RFM mice; inhibition of solid tumor formation by prior immunization with formalized leukemic spleen extracts; high titers of infectious Rauscher leukemia virus produced in vitro; bacteriology of microbiologically defined, as compared with conventional mice; quantitative interrelations of mouse plasma esterases in erythropoietin production. (H.L.W.)

8915 (ORNL-3999, pp 83-7) RADIATION IMMUNOLOGY. (Oak Ridge National Lab., Tenn.).

Progress is reported on the following studies: growth and decline of colony-forming cells in the spleens of neonatal mice; further studies on the secondary antibody-forming potential of juvenile, adult, and aged mice; development of immunologic competence in germfree and conventional mice; significance of a single-hit event in the initiation of antibody response; production of 7-S and 19-S antibodies in the mouse by a limited number of progenitor cells; protein synthesis in antibody-forming cells; engulfing potential of peritoneal phagocytes from conventional and germfree mice. (H.L.W.)

8916 (UCSF-34P41-15) CONSIDERATION OF THE ROLE OF AUTOIMMUNITY IN AGEING AND IN THE LATE EFFECTS OF IRRADIATION. Guttman, Paul H. (California Univ., San Francisco. Medical Center). Aug. 3, 1966. Contract AT(11-1)-34. 6p. (CONF-660635-4). Dep. mn. CFSTI $1.00 cy, $0.50 mn.

From International Colloquim on Radiations and Aging, Semmering, Austria.

A kidney disease known as intercapillary glomerulosclerosis (IGS) occurs in aging mice, rats, and hamsters. The pathological changes of this disease are acclerated by x radiation. A latent period precedes the onset of demonstrable changes. The possibility of an autoimmune factor in the pathogenesis of IGS of aging and irradiated mice was considered. Attempts were made to modify the course of radioinduced renal lesions by altering the immune response of the animals. Removal of the thymus at birth resulted in a significant potentiation of radiation effect on the kidneys. Splenectomy at 18 days after neonatal thymectomy markedly reduced the extent and degree of radiation response in the kidneys of animals irradiated at birth. Mechanisms by which radiation may induce antigenic response are discussed. The possibility that somatic mutation and chromosome aberrations may be responsible for senescence is discussed. The possible role of viruses in induction of autoimmune disease is discussed. (H.L.W.)

8917 (USNRDL-TR-1085) EFFECTS OF CONTINUOUS LOW-LEVEL GAMMA IRRADIATION ON CIRCULATING AND PERITONEAL MONONUCLEAR LEUCOCYTES OF MICE. Kornfeld, L.; Greenman, V. (Naval Radiological Defense Lab., San Francisco, Calif.). Oct. 20, 1966. 26p.

Mice were exposed continuously to ^{60}Co γ radiations at a dose rate of 1.4 rads/hr. The number of lymphocytes in the circulating blood fell sharply during the first week of exposure (190 rads) and decreased thereafter at a very gradual but statistically significant rate for the duration of the experiment (15 weeks, 3450 rads). The disappearance of small lymphocytes (6 μ in diameter) from the peritoneal cavity was also more rapid during the first week of irradiation than during subsequent weeks. Medium peritoneal lymphocytes (8 to 10 μ in diameter) and peritoneal macrophages disappeared at constant rates over the entire observation period. After the first week of exposure, the disappearance rates of small and medium peritoneal lymphocytes were identical. The rate was greater than that for peritoneal macrophages and that for circulating lymphocytes. Based on the fraction of cells surviving any given exposure, the mononuclear leukocytes may be arranged in the following order of decreasing sensitivity to continuous low dose rate γ irradiation: circulating lymphocytes, small peritoneal lymphocytes, medium peritoneal lymphocytes, peritoneal macrophages. The order is the same as that after acute exposure to x rays. (auth)

8918 (AEC-tr-6486/4A) ANTIBODY FORMATION IN IRRADIATED RATS. Simic, M.; Sijivic, V.; Petrovic, M.; Cirkovic, D. Translated from Bilt. Inst. Nukl. Nauke "Boris Kidric," 16: No. 4/A, Suppl., (1965). 162p. Dep. mn. CFSTI $5.00 cy, $1.00 mn.

Results are summarized from studies on the effects of x radiation on antibody synthesis in rats. Data are reviewed from other pertinent studies. (159 references.) (C.H.)

8919 CALLUS FORMATION IN IRRADIATED ANIMALS DURING SUTURATION OF BROKEN BONES. Bekmuratov, U. B. Med. Zh. Uzbekistana, 3: 14-15(1965). (In Russian).

Results are reported from a study of bone fractures in animals with radiation sickness. Callus formation by fractures repaired with metal pins was quite satisfactory. (C.H.)

8920 GIANT CELLS OF BONE MARROW IN ACUTE RADIATION SICKNESS. Goldberg, E. D.; Goldberg, D. I. (Tomsk Medical Inst., USSR). Probl. Gematol. Pereliv. Krovi, No. 4, 24-30 (Apr. 1965). (In Russian).

Guinea pigs were given whole-body betatron radiation at doses of 500, 1,000, 5,000, and 10,000 R. A direct correlation between radiation dose and number of giant hypersegmented neutrophils in bone marrow was noted. An increase in the number of reticular cells and large blast cells was noted on the second and third days. Formation of giant neutrophils and giant blast cells with differentiation into transient forms was pronounced as early as 18 hours after irradiation. The rapid formation of giant cells following massive radiation doses is evidence of the development of polyploidy within the nuclear membrane and increased DNA content; this results in increased volume of the nucleus and cell as a whole. It is thought that in the conversion of blast cells to neutrophils the multiple nuclei are formed from individual groups of chromosomes as occurs in the multipolar mitoses of cancer cells. Transitional forms of blast cells with fragmented nuclei and formation of daughter nuclei by a budding process was observed. (H.L.W.)

8921 ANALYSES OF AGE AT ONSET OF LEUKEMIA FOR ATOMIC BOMB SURVIVORS. Watanabe, Mineo (Hiroshima Univ.). Nagasaki Igakkai Zasshi, 38: Suppl., 146-9(Dec. 1963). (In Japanese).

Age factors affecting the onset of leukemia for atomic bomb survivors were studied statistically. The leukemia patients consisted of 123 persons from Hiroshima (67 male, 56 female) and 102 persons from Nagasaki (73 male, 29 female). The main factors affecting the age at onset of leukemia of atomic bomb survivors included residence in the city, sex, and age at the time of the bombing. There are correlations between the age at the time of the bombing, city residence, and sex of the atomic survivors. However, some variances were demonstrated on the correlation between the city residence and sex of the patients. These three factors are analyzed statistically in detail. (BBB)

8922 EFFECT OF IONIZING RADIATION AND INTERFERENCE IN THE FORM OF OPERATIONS ON THE CELL-PHAGOCYTIC REACTIVITY OF THE ORGANISM. Alaverdyan, M. I.; Gambaryan, L. S.; Papoyan, S. A.; Movsesyan, M. A.; Gezalyan, L. S. (Sector of Radiobiology, Academy of Medical Sciences, USSR. Lab. of Neurobionics, Academy of Sciences, Armenian SSR). Izv. Akad. Nauk Arm. SSR, Biol. Nauk., No. 11, 3-10 (Nov. 1965). (In Russian).

The phagocytic activity of leukocytes was studied in rabbits against the background of decortication of the brain, removal of the sympathetic nerve network, exposure to x radiation, and severe blood loss. A single exposure to x rays (800 and 260 R) resulted in the activation of phagocytosis within 24 hours after treatment and in a reduction of this reaction during the first, second, and third weeks of radiation sickness. The combination of radiation exposure with blood loss resulted in a sharp inhibition of phagocytosis, stronger than the effect of radiation alone. Blood loss by itself did not inhibit the phagocytic reactions of the leukocytes. Removing the abdominal sympathetic network along with radiation caused, as did both of these factors separately, a pronounced suppression of phagocytotic activity of leukocytes of rabbits in the later stages of the post-radiation period, but activated phagocytosis in the twenty-four hours following radiation and removal of the sympathetic network. Removal of the cerebral cortex caused a marked reduction in the level of phagocytosis. (JPRS)

8923 INFLUENCE OF RADIATION SICKNESS ON POST-MORTAL BIOCHEMICAL CHANGES IN THE TISSUES. Vranovska, J.; Kalousova, V.; Pawel, O. (Veterinary Research Center, Prague). Voj. Zdravot. Listy, 35: No. 2, 62-5(Apr. 1966). (In Czech).

Prompt killing of animals with radiation sickness may be necessary to avoid economic loss. The quality of meat, its preservation, and its suitability for processing were investigated. Pigs were subjected to 700 R radiation, and changes in pH, ammonia, and water content were observed at room temperature (about 20°C) and under refrigeration. The aging process was faster in the meat of irradiated animals and spoilage occurred sooner than in the meat of control animals. The spoiling process started about 2 days sooner in the meat of irradiated pigs when stored at room temperature, and even less than 2 days earlier in the refrigerated meat. The length of preservation was indirectly proportional to the degree of acute radiation illness suffered by the animals whose meat was tested. (ATD)

8924 A CONTRIBUTION TO QUANTITATIVE HISTOLOGY. III. THE EFFECTS OF X-RAY IRRADIATION ON THE NUMBER OF NUCLEI IN THE ORGANS OF MICE. Feng, Wen-hui; Lao, Wei-te; Shih, Lu-chi. Tung Wu Hsueh Pao, 18: No. 1, 1-7(Mar. 1966). (In Chinese).

The effect of whole body x irradiation on the total number of nuclei in cells of some mouse organs was studied. It was found that no statistically significant differences existed between the total numbers of nuclei of the cerebrum, the liver, and the kidney, and those of their controls 24 hours after 1200 R irradiation. In the case of the spleen, the total number of nuclei was found to be significantly different from that of the control 24 hours after 300 R, 600 R, or 1200 R irradiation. (JPRS)

8925 SYMPTOMATOLOGY, CLASSIFICATION, AND EXPERTISE OF UHF AFTEREFFECTS ON THE HUMAN ORGANISM. Panov, A. G.; Tyagin, N. V. Voenno-Med. Zh., No. 9, 13-16(1966). (In Russian).

There is conclusive factual evidence of the definite biological effects of UHF fields, which may either produce organic disorders or serve therapeutic ends. Neurological and visceral dysfunctions observed in persons working near UHF generators may be grouped into syndromes. The asthenic syndrome is characterized by onset of fatigue and lowered emotional tonus, which may or may not be accompanied by autonomic disturbances (autonomic lability, acrocyanosis, sweating, heightened pilomotor reflexes, dermographism, and pulse and BP lability during orthostatic tests). The asthenic syndrome does not include fainting. Changes are reversible and often respond to dispensary treatment. The autonomic-vascular dystonia syndrome centers on vascular lability (fluctuating pulse and BP is characterized by alternating brady- and tachycardia, alternating arterial hypotonus and hypertension, EKG changes, capillary shifts, etc.). This syndrome may be accompanied by other autonomic dysfunctions and syncope. Asthenia does not occur. This syndrome is persistent and usually requires hospital care. The diencephalic syndrome is characterized by complex visceral dysfunctions and crises, may be accompanied by asthenic disturbances, apathy, hypersomnia, hypokinesia, hypothalamus-hypophysis-adrenal weakness (overt or latent), and depression of sexual and alimentary reflexes. These changes are not always reversible, and hospital care is required. Diagnosis of UHF-caused disorders must include medical evaluation of the UHF source and exposure conditions (field intensity and exposure duration), as well as the character and severity of damage. (ATD)

8926 FAST-NEUTRON SOURCE FOR RADIOTHERAPY. Berry, Roger J. (Churchill Hospital, Oxford); Ellis, Roy E. Nature, 211: 267-8(July 16, 1966).

Reproductive capacity was studied in P-388 lymphatic leukemia cells exposed to 14 MeV monoenergetic neutrons. Survival curves were constructed for anoxic tumor cells in donor mice that were irradiated 7 days after the intraperitoneal injection of 10^6 cells. Surface dose and dose at a depth of 10 cm were compared in tumor-bearing animals and a tissue-equivalent phantom. Results extend the survival curve for 14 MeV neutrons below one cell in a thousand. There was relatively little difference in the biological response of mammalian tumor cells to 14 MeV monoenergetic neutrons and to fast neutrons of a quite similar LET from a cyclotron. (H.G.D.)

8927 SERUM PROTEIN FRACTIONS IN CHRONICALLY X-IRRADIATED RATS. Panov, D.; Delic, V.; Ilic, V.; Kilibarda, M. Kujovic, B.; Zivancevic, S. (Inst. for Occupational Medicine, Belgrade). Arhiv Farm. (Belgrade), 15: 273-8(1965). (In Croatian).

A study was made of 30 rats irradiated twice weekly with 5 R for a total dose of 140 R to the skin in 105 days. Electrophoresis of serum proteins showed considerable decrease in β-globulins, slight decrease of albumins and α2-globulins, and no change in gamma globulins. (JPRS)

8928 EFFECTS OF ACUTE GAMMA IRRADIATION ON THE BLOOD CONSTITUENTS OF PINFISH, LAGODON RHOMBOIDES. Engel, David W. (Bureau of Commercial Fishing, Beaufort, N. C.); Angelovic, Joseph W.; Davis, Edna M. Chesapeake Sci., 7: No. 2, 90-4(June 1966).

The relative radiation sensitivities of various cellular constituents of the blood of a marine fish, pinfish, were determined, and the hematological responses of the marine fish were compared with those of a freshwater fish. The data indicate that hematological radiation responses for any one species cannot be extended to another. (auth)

8929 RADIATION: A LOOK AT THE PAST AND THE PRESENT. Beauchamp, I. L. (Univ. of California, Los Angeles). J. Occup. Med., 8: 329-37(June 1966).

A survey is presented covering the development of man's knowledge of radiation and its application in the fields of the biological sciences. Included are early theories of radiation injury, early development of radiation detection instruments, and a comparison of past and recent injury rates. The author concludes with a statement that additional research is needed to further the progress in the areas of radiation detection and that more standards are required for dosimetry and exposure levels. (TSS)

8930 THE RELATIONSHIP BETWEEN THE OXYGEN CONSUMPTION OF VARIOUS TISSUES AND THE RADIOSENSITIVITY IN MICE. 2. THE OXYGEN CONSUMPTION OF VARIOUS TISSUES IN THREE STRAINS OF MICE AFTER WHOLE BODY X-IRRADIATION. Tsuchiya, Takehiko (National Inst. of Radiological Sciences, Chiba, Japan); Okamoto, Kazuo. Nippon Igaku Hoshasen Gakkai Zasshi, 26: 302-8(June 1966). (In Japanese).

The oxygen consumption of various tissues (kidney, liver, and spleen) in three strains of mice (C57BL/6, RF and CF # 1), which have different radiosensitivity, was measured in vitro after whole-body x irradiation. After exposure to a near-lethal dose of x rays (650 R in C57BL/6, 550 R in RF, and 530 R in CF # 1), the oxygen consumption showed a decrease in all tissues of each strain on the 3rd day. The degree of decrease in oxygen consumption was less in tissues of C57BL/6 mice than that in RF and CF # 1, in terms of the percentage of QO_2 in each normal tissue from these strains of mice. A similar tendency in the order of decrease in oxygen consumption among these three strains was found on various days (3 to 30 days) after irradiation with 350 R and also 3 days after irradiation with various doses (150 R, 350 R, 530 R, 550 R, and 750 R). The results agree with those of radiosensitivity among these three strains of mice. (auth)

8931 RESTORATION OF GAMMA GLOBULIN PRODUCTION IN AGAMMAGLOBULINEMIC CHICKENS. Cooper, Max D.; Schwartz, Melvin L.; Good, Robert A. (Variety Club Heart Hospital, Minneapolis.). Science, 151: 471-3(Jan. 28, 1966).

Bursectomy of young chickens and nearly lethal total-body irradiation at hatching prevents development of germinal centers and plasma cells and results in agammaglobulinemia and complete failure of antibody production. Attempts to provide bursectomized-irradiated newly hatched chickens with the missing cell system were made by administration of their own bursal cells. Germinal centers, plasma cells, and γ-globulin production were restored, but significant amounts of agglutinating antibodies to both bovine serum albumin (BSA) and whole Brucella organisms were not produced. Newly hatched White Leghorn chickens were bursectomized and this group and an unoperated control group were irradiated with 740 R. In birds injected with bursal cells, spleen cells and cecal tonsil tissues regularly revealed numerous plasma cells and frequent germinal centers. Germinal centers and plasma cells were completely absent in untreated bursectomized-irradiated birds. No differences could be detected between the lymphoid tissues of experimental birds and those irradiated only in the newly hatched period and stimulated with the same antigens at 40 days of age. Immunoelectrophoresis revealed both 19S and 7S γ-globulin in the blood of birds that had received the autologous cells. The bursectomized-irradiated chickens showed no detectable formation of either γ-globulin. Thus, irradiation and bursectomy combined were necessary to prevent germinal center and plasma cell development because in chickens surgically or hormonally bursectomized, as well as in those chickens receiving irradiation alone or with thymectomy, both germinal centers and plasma cells develop. It is suggested that germinal centers and plasma cells might represent a direct cell lineage. (BBB)

8932 EXPERIMENTAL PULMONARY SCLEROSIS FROM γ RAYS. III. PRELIMINARY RESULTS ON THE PRESENCE OF DELAYED SENSITIVITY TO PULMONARY ANTIGENS IN IRRADIATED RABBITS. Tison, V.; Mancini, A. M.; Corinaldesi, A.; Ferracini, R. (Univ., Bologna). Boll. Soc. Ital. Biol. Sper., 41: 805-7(July 31, 1965). (In Italian).

Evidence for autoantibodies to irradiated lung was sought in rabbits which received local doses of irradiation in the therapeutic range (4900 rad to a 5 × 5 cm field). Two courses of ^{60}Co γ radiation were given some rabbits. Cutaneous hypersensitivity was examined three months after irradiation by subcutaneous injections of lung and liver homogenates from normal and irradiated rabbits. One hour after such injections, clear differences were noted in results with irradiated as compared with control lung, while liver did not show such differences. Nonirradiated lung tissue caused only a transient swelling and reddening of the injection site, whereas irradiated lung caused a more severe, prolonged reaction. Histologic examination of the injection sites showed a marked inflammatory infiltration in the case of irradiated lung. The hypersensitivity thus induced appeared to be of the delayed type, not mediated by circulating antibody. This reactivity could be passively transferred with immunoreactive cells to recipient rabbits. (BBB)

8933 EXPERIMENTAL PULMONARY SCLEROSIS FROM γ RAYS. II. HISTOIMMUNOLOGIC FINDINGS. Mancini, A. M.; Tison, V.; Corinaldesi, A.; Rimondi, C. (Univ., Bologna). Boll. Soc. Ital. Biol. Sper., 41: 802-5(July 31, 1965). (In Italian).

Fluorescent antibody studies were conducted on rabbits subjected to thoracic irradiation over a 5 × 5 cm field with 700 rad daily doses of ^{60}Co γ rays. Total doses reached 4900 rad, and some rabbits received a second course of irradiation (1000 rad daily for five days). An increase in antibodies to the animal's own lung tissue was sought by both the direct and indirect fluorescent antibody technics. Two of eight animals appeared to have antipulmonary antibodies after irradiation, which was associated with an increase in serum γ-globulins. The staining was specific and directed at reticular fibrils. Normal γ-globulin did not bind these fibrils. This evidence is interpreted as indicating the formation of autoantibodies to irradiated lung and it is suggested that these antibodies may play a pathogenic role in radioinduced pulmonary fibrosis. (BBB)

8934 EFFECTS OF X-RADIATION ON THE EYE OF THE ONE-YEAR-OLD AXOLOTL (SIREDON MEXICANUM). Brunst, V. V. (Roswell Park Memorial Inst., New York). Exp. Eye Res., 5: 116-22(Apr. 1966).

The anterior portion of each head of 30 one-yr-old axolotls was irradiated with 4000 R. Specimens were fixed at various intervals following irradiation and studied histologically. Considerable differences were found between specimens at 53 to 100 days after irradiation and specimens at 230 to 280 days. All the corneas of early specimens were damaged, the injury being moderate in most cases, but serious in some. The lenses and retinas were normal or only slightly damaged in most cases. The corneas of late specimens, however, were normal or only slightly damaged in most cases; obviously, the cornea was never entirely destroyed and was able to recover more or less completely. All the lenses were damaged, the injury being severe in most cases and moderate in some. The gradual destruction of the lens was due to the activity of macrophages, which partially phagocytosed the lens fibers and partially dissolved them. The retinas were damaged severely in rare cases, moderately in most cases, slightly in some cases, and not at all in one case. Evidently, the lens is the most radiosensitive part of the eye of one-yr-old axolotls, but the injury takes time to become apparent. In contrast, the cornea is appreciably less sensitive, undergoing moderate-to-severe injury at first, but recovering later. The most sensitive part of the retina is the rod-and-cone layer. Response of the eye of the one-yr-old axolotl to x radiation was similar to that of younger animals. However, in the lens of the one-yr-old axolotl, irradiation was followed by development of pigmentation, which was not seen in the lenses of younger animals; also, recovery of the cornea was never observed in younger axolotls. (BBB)

8935 X-RAY THERAPY AND COMBINED THERAPY (X-RAY AND 5-FLUOROURACIL) IN THE TREATMENT OF CANCER OF THE LUNG. Fingerhut, Aaron G.; Barnett, Michael B. (Harbor General Hospital, Torrance, Calif.). Dis. Chest, 49: 393-5(Apr. 1966).

An attempt was made to determine whether 5-fluorouracil (5-FU) would augment the effect of x radiation in the treatment of advanced, inoperable lung cancer. Eleven patients were treated with x-ray therapy alone, a 900- to 4200-R tumor dose with most receiving 2000 to 3000 R. Eleven patients were treated with 5-FU and x-ray therapy, consisting of a 742- to 3500-R tumor dose with most patients receiving ~2000 R. Treatment times were two to three weeks for most patients in this group. 5-FU therapy was started on the first day of x-ray therapy in each case, and was administered intravenously over a 5- to 10-min period two to 6 hr prior to the daily x-ray therapy. Of the 11 patients given combined therapy, three had good objective responses defined by the above criteria and none of these developed signs of toxicity. All but one of those patients not responding to combined therapy, however, did manifest toxic symptoms (stomatitis, nausea, vomiting, and diarrhea). Severe toxic reactions occurred in four and included marked leukocyte depression, bronchopneumonia, septicemia, and gastric ulcer with bleeding. Of the group receiving only radiation therapy, only one showed a good objective response. This patient received a 4100-R tumor dose, somewhat higher than the rest of the group. There were no toxic reactions and no deaths due to x-ray treatment alone. Those receiving combined therapy survived an average 3.2 months, while those receiving only radiation therapy on an average survived 3.45 months. While the combined approach showed a slightly better response rate, toxicity was great and two patients died, so that this combined approach to cancer of the lung is not recommended. (BBB)

8936 CONNECTIONS BETWEEN THE INTENSITY OF FLUORESCENCE, TEMPERATURE, AND EXPOSURE TO ULTRAVIOLET LIGHT IN EPITHELIAL CELLS. Donath, T. (Univ. Medical School, Budapest). Acta Morphol. Acad. Sci. Hung., Suppl. 13: 45(1965).

By a newly developed method for the semi-quantitative estimation of fluorescence, the effect of different temperatures, also that of uv light, on the intensity of fluorescence in model-experiments was studied in epithelial cells treated with different concentrations of acridine orange. The intensity of fluorescence was found to increase considerably between 18° and 30°C, a phenomenon presumably due to a dissociation of the nonfluorescent molecules caused by the increased temperature. The duration of fluorescence was found to depend on the nature of the binding between the molecules of the cells and those of the fluorescent dye. If the bond is physical, fluorescence is soon extinguished, whereas it is stable if the bond is chemical. The decrease in the intensity of fluorescence, due to continuous uv excitation, depends, thus, on the nature of the linkage between the dye and the chemical structure of the cell. (BBB)

8937 EFFECTS OF IONIZING RADIATION ON TOLERANCE AND ANTIBODY FORMATION. Stoner, R. D. (Brookhaven National Lab., Upton, N. Y.). Int. Arch. Allergy Appl. Immunol., 27: 373-6(1965).

An attempt was made to render newborn mice tolerant of donor rat cells so that these animals could later be used as immunologically tolerant irradiated recipients. The newborn mice were injected within six hours after birth with a mixture of frozen and thawed cells prepared from rat bone marrow, thymus, spleen, and lymph nodes combined with a cold saline and trypsin antigen extract of these donor cells. It was not possible to elicit recall antibody responses from the sensitized rat cells after their transfer to the tolerant irradiated recipient mice. In a similar experiment, both prospective donor rats and prospective recipient mice were injected at birth with each other's killed-bone marrow and spleen cells along with antigen extracts of these cells. Prospective tolerant donors and prospective tolerant recipients were not tested with grafts of each other's skin to determine if they were actually immunologically tolerant of one another. It was not possible to elicit recall antibody responses from the transplanted spleen and bone marrow cells following their injection into the irradiated tolerant recipients. Perhaps the cells were unable to respond to the original antigen due to an antigenic crowding-out phenomenon resulting from an overwhelming challenge of excess host antigens present in the irradiated recipients. Since the relative amounts of antigen required to induce unresponsiveness in newborn and adult animals and irradiated animals may be of importance, a comparison was made of the relative effectiveness of various doses of antigen only and antigen complexed at equivalence with isologous antitoxin, needed to elicit primary antibody responses in irradiated and nonirradiated mice. Enhanced primary tetanus antitoxin responses were obtained in both irradiated and nonirradiated mice immunized with complexes of tetanus toxoid and specific mouse antitoxin when complexes were prepared in ratios of antigen excess, equivalence, and antibody excess. Radiation doses of 300 R had little if any repressive effect on primary antitoxin responses when the animals were immunized with the complexed toxin. The threshold dose of antigen required in irradiated animals was lowered about 1900 times when toxin was given in complex with specific isologous antitoxin as compared with immunization with antigen only. (BBB)

8938 SPECIFIC PROTEINS IN SERUM OF TOTAL-BODY IRRADIATED HUMANS. Luzzio, A. J.; Friedman, B. I.; Kereiakes, J. G.; Saenger, E. L. (Army Medical Research Lab., Fort Knox, Ky.). J. Immunol., 96: 64-7(Jan. 1966).

Antibodies stimulated by radiation-altered human serum γ-globulin (HSGG) (anti-XI-HSGG) were used to detect specific antigens in the serum from seven patients who had received total-body irradiation for malignancy. Patients received total-midline air doses of 149 to 238 R (absorbed doses of 100 to 150 rad) of ^{60}Co γ radiation given at an air dose rate of 5 R/min. Changes in antibody N precipitated from anti-XI-HSGG by the sera of six human patients before and after a single exposure were examined. The amount of precipitated N rose in all patients immediately following irradiation and fell to the preirradiation level in about 5 days. Thereafter, the amount of precipitated N showed wide fluctuations between subjects. This suggests that irradiation directly modified preformed protein so as to alter its specificity, that it causes increased release of preexistent molecules specific for anti-XI-HSGG into the serum, or both factors may be operative. When each subject was considered his own control, the data suggested that a decline in precipitated N to below base line levels followed the initial rise and preceded a secondary elevation. This suggests temporary inhibition of protein synthesis. (BBB)

8939 RECENT DEVELOPMENTS IN BIOLOGIC EFFECTS OF LASER RADIATION. Fox, John L. (Veterans Administra-

tion Hospital, Washington, D. C.); Green, Robert C.; Hayes, Jude R. Med. Ann. Distr. Columbia, 34: 353-6(Aug. 1965).

Biological and medical studies on the effect of laser radiation are reviewed. A major problem in assaying the biologic effects of laser radiation is that of being able to measure accurately the actual amount of energy released by the laser cavity and that absorbed by the target during a single pulse of laser radiation. Measurement of amount of energy reflection, absorption, and transmission as the laser beam interacts with a living object within milliseconds is difficult. A single 0.5-J pulse of red ruby laser light lasting 0.5 msec may cause the following injury when focused on the retina: a small chorioretinal hole surrounded by a 0.2-mm diameter zone of black charring surrounded by a 0.6-mm diameter zone of blanched coagulated tissue surrounded by a cuff of edema. A small gas bubble forms, and focal hemorrhages frequently occur. A few weeks later adhesions between the choroid and retinal layers are seen with necrosis and inflammatory cells at the focal point. Hazards to eyes of personnel working with laser equipment are considered. Special copper sulfate-impregnated glass is recommended for goggles to be worn by personnel working with the red or ir laser spectrum. Effects of laser energy on skin, brain, and tumors are described. There seems to be a selective effect on cancer tissue, which is much more adversely affected than the normal tissue, and pigmented tumors are the most readily destroyed since they absorb more light energy. Neoplastic tissue beyond the zone of direct laser radiation also appears to degenerate over a few days following radiation. There is as yet no clinical justification for substitution of laser radiation for present methods of cancer therapy. Various wavelengths (such as blue-green and uv) need to be studied. (BBB)

8940 INCORPORATION OF ACETATE-1-^{14}C INTO LIPIDS BY THE PERFUSED LIVER OF NORMAL, X-IRRADIATED, OR PARTIALLY HEPATECTOMIZED RATS. Bartsch, Guenter G.; Gerber, Georg B. (Univ., Cologne). J. Lipid Res., 7: 204-9 (Mar. 1966).

A study was made of the synthesis of various lipid fractions in perfused normal, regenerating, and x irradiated rat livers. Male Wistar rats, 3 months old, were starved for 18 hr prior to perfusion. Partial hepatectomy was performed 24 hr before perfusion, and total-body x irradiation (1000 R) was also carried out 24 hr prior to perfusion. The livers were isolated and perfused with acetate-1-^{14}C and the distribution of radioactivity in total lipids, total fatty acids, individual lipids, and fatty acids of individual lipids was determined. In x irradiated animals, an increased incorporation of acetate into many lipids, particularly into cholesterol, was observed. Lipids in the liver of the partially hepatectomized rats exhibited a marked increase in triglyceride content together with a decreased rate of incorporation into all but the phospholipid fractions. It is concluded that the increase usually observed in lipid content of the regenerating liver is due to the changes in transport rather than to changes in synthesis. The changes observed in irradiated liver could be the result of alterations in the metabolism of precursors common to most lipids. (BBB)

8941 REMARKS ON THE PANEL DISCUSSION "THE ACUTE RADIATION SYNDROME, ITS MEDICOMILITARY AND PUBLIC HEALTH STATISTICAL SIGNIFICANCE." Isler, W. (Univ., Zurich). Vierteljahresschr. Schweiz. Sanitaetsoff., 42: 40-2 (May 1965). (In German).

The author discusses the types of properties of various ionizing radiations, fallout, intensity of radiation, accumulated dose, decay laws, incorporation of radioisotopes, definitions of rem and R units, and various effects of nuclear explosions that are related to their detonation point and energy equivalents. It is concluded that extensive training will be required to fully acquaint army troops and members of the medical staff with adequate information on atomic warfare effects. (BBB)

8942 FALLOUT RADIATION AND GROWTH. Brit. Med. J., 1: 1132(May 7, 1966).

Several recent reports on growth retardation of irradiated children are reviewed briefly. Studies of the effects of the atomic explosions in Nagasaki and Hiroshima have shown, among other things, the risk of anencephaly or microcephaly in children born to mothers exposed in early pregnancy. Growth retardation occurred in children who were exposed to heavy fallout radiation on two atolls in the Marshall Islands in March 1954 after the experimental detonation of a thermonuclear device over Bikini Atoll. Retardation was found in both stature and skeletal maturation in boys who were under the age of 5 years when exposed to the radioactivity, and this was most evident in those who were exposed at ages between 12 and 18 months. There was no significant difference between exposed girls and the controls. The growth curve of the boys ran parallel to those of the unexposed controls, but their stature remained 5 to 10 cm shorter. There was no difference between the unexposed and exposed boys aged 6 to 12 years at the time of the explosion. No biochemical variations from normal were found in the mineral metabolism or endocrine function of the boys. (BBB)

8943 RELATIVE BIOLOGICAL EFFECTIVENESS OF FISSION NEUTRONS IN WHOLE-BODY IRRADIATION OF MICE. Mewissen, D. J. (Univ. Libre, Brussels). Compt. Rend. Soc. Biol., 160: 873-5(1966). (In French).

Mice were divided into 14 groups of about 35 each. Five groups were given gamma radiation from a cobalt-60 source and nine groups were irradiated with fission neutrons from a reactor. Each group was given a different dose. The LD_{50} was 589 rads for cobalt-60 radiation and 427 rads for neutron radiation. The RBE of fission neutrons in proportion to cobalt-60 radiation has been estimated in pathogen-free mice to be 1.8 for a dose of about 17 rads per minute and using the criterion of death at 30 days. (H.L.W.)

8944 PROTECTIVE EFFECT OF CYSTAMINE ON X RAY INHIBITION OF COMPENSATORY HYPERPLASIA. Smoliar, V. (Univ., Liege). Compt. Rend. Soc. Biol., 160: 876-8(1966). (In French).

In rats and mice unilateral nephrectomy results in increased mitosis in the intact kidney 2 days later. This response is considerably diminished if the animal is irradiated before the nephrectomy. It was decided to study the effect of a radioprotective agent, cystamine, on this phenomenon. Rats were divided into control and experimental groups. The experimental rats were given whole-body x irradiation at doses of 500 and 900 R. Cystamine was injected into one group ten min before irradiation. Nephrectomy was performed one hour after irradiation in those irradiated at 900 R and 7 days later in those irradiated at 500 R. Forty-eight hours after nephrectomy the animals were killed and the intact kidney was removed and sectioned for histological study. Cells showing mitosis were counted under oil immersion and the number was expressed in proportion to 100 microscopic fields. In the non-irradiated rats the average number of mitoses was 5 per 100 microscopic fields. After nephrectomy the number increased to 76 per 100 microscopic fields. The number of mitoses in irradiated nephrectomized rats was only 30% that of the controls. In irradiated nephrectomized rats treated with cystamine, the number of mitoses was 90% that of the controls. (H.L.W.)

8945 EPIDERMAL IRREGULAR DENSE BODY: CORRELATION OF ULTRASTRUCTURAL HISTOCHEMISTRY WITH BIOCHEMICAL CHARACTERISTICS. Nix, Thomas E. Jr.; Black, Owen Jr.; Nordquist, Robert E.; Anglin, J. H.; Everett, Mark Allen (Univ. of Oklahoma, Oklahoma City). J. Invest. Dermatol., 45: 432-46(1965).

Electron microscopic investigation of changes in human and guinea pig epidermis following uv irradiation revealed that there is a large increase in numbers of an irregular dense body found in the cytoplasm of basal layer cells. The nature of this uv-induced dense body was studied by electron microscopic, histochemical, and biochemical techniques. (C.H.)

8946 EXPERIMENTAL STUDIES ON THE EFFECTS OF ^{60}Co GAMMA IRRADIATION ON THE BRAIN OF CATS. Imamura, Kazuhide (Kagoshima Univ., Japan). Igaku Kenkyu, 34: 458-86 (Dec. 1964). (In Japanese).

Histopathological changes in the cat brain caused by irradiation with ^{60}Co γ rays are reported. Fractional irradiation of the brain of cats with a dose of 200 R daily for 30 days was carried out, for a total of 6000 R in four cats. No changes of an irreversible nature were found in the brain. When a dose of 250 R, once a day continuously for a period of 20 days up to a total of 5000 R, was given, some nerve cells showed severe changes even though the total dose was less than in the other cats. In the cats in which the supertherapeutic doses were given the small blood vessels showed dilation (teleangiectasia). Regressive degeneration of nervous parenchyma was generally conspicuous. The distal end of the cell cytoplasm was liquefied and it became difficult to stain, making the limits of the cell indistinct. PAS-positive granules were often found in the walls of small vessels or perivascular spaces. The granules were found especially in the perivascular spaces as a homogeneous substance. This suggests an increase of the permeability of the vessels. In some cases a swelling of the myelin sheath occurred, and as a result of this the white matter showed a tendency of rarefaction and a spongy degeneration. This suggests the presence of brain edema. However, a relation between these phenomena and dilation of perivascular spaces could not be found. Pyknosis of the granule cells of the cerebellum was also seen in irradiated animals; this was always accompanied by severe changes of the nerve cells in the brain, and of the Purkinje cells in the cerebellum. It appears to be of an irreversible nature.

Therefore, pyknosis of the granule cells indicates death of these cells. (BBB)

8947 STUDIES OF THE IRRADIATION EFFECTS ON CELLS. VI. THE IMMEDIATE EFFECTS OF X-RAYS ON HeLa CELLS AS STUDIED WITH THE FLUORESCENCE MICROSCOPE. Kobayashi, Jindo; Yoshizaki, Tsutae; Kawamura, Fumio (Tokushima Univ., Japan). Tokushima J. Exp. Med., 12: 51-6(May 1965).

This study was undertaken to determine the immediate effects of x radiation on tissue cultured HeLa cells by the fluorescence microscope, using acridine orange. After incubation of the culture for four days, the cells on a half cover slip were exposed to 1000- to 5000-R doses of x rays and the cells on the other half cover slip were used as control. The irradiated cells were stained, together with controls, from immediately after to 60 min after the exposure (exposure time, 5 to 20 min). Morphologically, the cells were not changed immediately after irradiation. The fluorescent color in the cytoplasm became an intense red, clearly distinguished from the orange color of control cells. The nucleus became smaller than in the controls and the nuclear membrane in some cells separated from the cytoplasm. These investigations have shown that irradiated cells can readily be distinguished from control ones using acridine orange. (BBB)

8948 RISK OF RADIATION TO THE RADIOLOGIST. J. Amer. Med. Ass., 198: 312(Oct. 17, 1966).

Early and recent evidence of an occupational hazard to radiologists from exposure to ionizing radiation is briefly reviewed. Early investigators who used x rays suffered radiation burns, almost invariably of the hands and fingers, and other radiation hazards were recognized but not clearly documented. A relation between exposure to radiation and leukemia has been suggested by several studies though an exact demonstration is lacking, perhaps because radiologists entered the specialty at a comparatively late age, during beginnings of the specialty. Data from Hiroshima and Nagasaki yielded a heightened incidence of leukemia among heavily exposed survivors. However, some of the dangers of radiation to radiologists suggested that the danger was not specifically that of leukemia, but that radiologists died at earlier ages from a variety of causes. These figures, challenged by some investigators, have served as a basis for more careful epidemiological investigation. Ten years after these first reports, which were relatively crude studies, important additions have now been made. One of the latest studies by Warren shows that in the past the hazard of leukemia to the radiologist has been real but that today the danger to the radiologist and nonradiologist is the same. From this data and those from the United Kingdom, it is concluded that when proper attention is paid to safety precautions, and when the maximal permissible dose levels are observed, the special hazards to radiologists can be avoided. (BBB)

8949 SOME ASPECTS OF HYPOTHYROIDISM SECONDARY TO TREATMENT WITH RADIOIODINE. Ciabotti, Arnaldo (Casa di Cura Villa Andria, Ancona, Italy). Minerva Med., 56: 2650-6 (Aug. 18, 1965). (In Italian).

The occurrence and characteristics of hypothyroidism as a late complication of the ^{131}I therapy of hyperthyroidism were examined. This side-effect of ^{131}I treatment developed in 15 to 20% of the patients examined and was of an irreversible nature. In some the hypothyroidism was manifested by frank myxedema and in others it could be detected only by special tests. Fourteen such cases of hypothyroidism caused by ^{131}I were examined in detail. Three cases developed this condition within one year of ^{131}I treatment, the others at later times. All 14 cases experienced asthenia, six showed skin changes characteristic of myxedema, five had radiographic evidence of cardiac enlargement, five had elevated serum cholesterol levels, and in six the basal metabolic rate was low. Electrocardiograms of the patients are illustrated and commented upon. Muscle weakness appeared to be particularly evident in ^{131}I-induced myxedema. Diagnostic criteria for hypothyroidism following ^{131}I treatment are established. (BBB)

8950 INTESTINAL COMPLICATIONS OF RADIATION THERAPY. Barnes, Z. B. J. Med. Ass. State Ala., 35: 349-52(Nov. 1965).

The literature concerning radiation injuries to intestine after radiotherapy is reviewed and the author's three-yr experience with six cases is summarized. Attention is called to the fact that many patients who die of complications of radiation therapy are cured of carcinoma. These patients are often debilitated, chronically ill, and poor risks for major surgery. The pathologic lesion marked by intense fibrosis, arteriolar changes, and poor tissue healing will defeat an attempt to resect and anastomose unless normal intestine is re-united. Therefore, the surgical approach must be both aggressive and conservative, with an unavoidably high mortality rate. The total amount of radiation given in most of the cases reported in the literature is at least 4500 R, but the dose producing damage is individually variable. Some patients have been mistakenly retreated with both radium and x ray without full knowledge of past therapy, and with disastrous results. However, even with the best available therapy given with judicious control, the intestine is sometimes damaged. Pathologic changes due to radiation injury are described. The time of onset of intestinal complications following radiotherapy may vary from several months to many years later, with an average time interval of about two years. Each of the six patients described underwent surgery and radiation therapy as treatment for the primary gynecologic carcinoma and was referred for surgical treatment of complications of radiation therapy. Three of these six patients died from sequellae of radiation and not from carcinoma. (BBB)

8951 CAROTID ARTERY RUPTURE AFTER IRRADIATION OF LARYNX. Roscher, Arno A. (Granada Hills Community Hospital, Calif.); Steele, Burns C.; Woodard, John S. Arch. Otolaryngol., 83: 472-6(May 1966).

The rupture of the carotid artery was observed seven years following irradiation for carcinoma of the larynx with successful eradication of the malignancy. The patient received a total of 24 radiation treatments, the dose totaling 4000 R in air bilaterally. This was considered to correspond to a tumor depth dose of 6000 R. The treatment was tolerated well except for a transient moist reaction of the skin which developed into mild skin atrophy. No recurrence of tumor was noted, and the patient was asymptomatic for the ensuing five years. Progressive postradiation tissue changes led to a fistula between the common carotid artery and the pharynx, and fatal hemorrhage seven years after irradiation. Pathologic changes appeared to be primarily vascular with secondary widespread fibrosis. Although it has been generally believed that elastic fibers are resistant to the effects of irradiation, findings in this study suggest susceptibility of the elastic fibers to radiation damage after relatively long survival. (BBB)

8952 EFFECTS OF ADDING GAMMA-IRRADIATED GREEN BEANS OR FRUIT COMPOTE TO THE DIET OF DOGS. Larson, P. S.; Belter, Lester F.; Crawford, E. M.; Haag, H. B.; Finnegan, J. K.; Smith, R. Blackwell Jr. (Medical Coll. of Virginia, Richmond). Toxicol. Appl. Pharmacol., 3: 57-62(Jan. 1961).

Possible harmful effects of γ-irradiated foods (3 and 6 MRep) were investigated in nutritional, fertility, and histopathologic studies. Irradiated and nonirradiated green beans and fruit compote were added to the diet of pure-bred beagle dogs in amount equal to 35% of the dry solids fed for a period of 2 yr. No effects attributable to irradiated food were apparent as regards growth, food efficiency, reproduction, hematology, or histopathology. A possible exception was a trend toward increased spleen weight in animals receiving the irradiated food. Histologically, the larger spleens were characterized by a relatively higher blood content. The biological significance of this, if any, is unknown. Other organ weight data obtained at necropsy showed no treatment-related differences. (BBB)

8953 CHORIORETINAL LESIONS PRODUCED BY LASER ON MONKEYS AND RABBITS. Santos, Raul (Univ. of Mexico Medical School, Mexico City); de Buen, Sadi; Abraham, Robert K. Amer. J. Ophthalmol., 61: 230-40(Feb. 1966).

Ocular effects of the laser beam were evaluated using a ruby laser with a direct ophthalmoscope head to produce chorioretinal lesions in 10 monkeys and 50 rabbits. The energy output varied from 0.01 to 0.03 J, and the beam divergence from 4.5 to 90 milliradians. In the early stages, medium intensity lesions in monkeys showed changes in the retinal pigment epithelium and more advanced alterations in the outer layers of the retina. Pigment granules were present in the inner retinal layers, including the nerve-fiber layer and reaching the inner limiting membrane. Clinically, these alterations resembled gun-powder burns. After two weeks, there was a wider but still localized degenerative process of the retina, with total destruction of the rod and cone layers and disorganization and atrophy of the nuclear and ganglion cell layers. The chorioretinal lesions obtained in monkeys showed a variety of intensities and a close similarity to the reactions of human eyes. By controlling the energy output and divergence, it was possible to obtain clinically useful lesions. The histologic study showed chorioretinal adhesion with no disturbance of the vitreous in lesions of medium intensity. Rabbit eyes proved more sensitive; threshold intensities always produced chorioretinal lesions. Alteration of the pigment epithelium was a constant finding in all cases. The characteristics of the lesion were those of a thermal burn, and no other effect, as has been suggested for high energy lasers, was seen. Long-range studies are required to rule out late effects. In the selected human cases of retinal detachment treated, a follow-up of four months showed that satisfactory results were obtained. (BBB)

8954 BIOLOGICAL EFFECTS OF LASER RADIATION. Litwin, Martin S. (Tulane Univ., New Orleans); Glew, Donald H. J. Amer. Med. Ass., 187: 842-7(Mar. 14, 1964).

The fundamentals of laser instrumentation and operation, effects on animal tissues, and hazards to operating personnel are reviewed. Retinal effects of laser irradiation are described. Since intense amounts of light may be focused into small areas of the retina, retinal burns may thus be produced readily. If the area of injury lies in the macula, the area of visual acuity, significant visual loss may result. Energy density at the point of impact of the direct laser beam is great, so that conduction is not rapid enough to allow cooling to occur, and vaporization of the vitreous with disruption of the choroid may occur. Also described are the effects of laser radiation on the skin. If laser radiation of low energy is employed, and the skin is pigmented or covered with dark hair or with a lampblack-in-cold-cream mixture, energy is absorbed superficially in that layer, the layer vaporized, and no burn occurs. With a relatively low-powered ruby laser, when various types of tissue cultures are irradiated, pigmented cells are selectively destroyed, whereas nonpigmented cells transmit the beam without apparent immediate effect. But more subtle changes can be detected later. Following laser irradiation, transparent cells may demonstrate a marked decrease in oxygen consumption. When the beating chick embryo heart in tissue culture is irradiated, there is a slowing of the contraction rate that returns to normal after a short time. Injury of various types of tumor cells from laser radiation is also described, and application of this source to oncology is referred to. (BBB)

8955 CONVULSIVE RESPONSES IN PRENATALLY IRRADIATED RATS. **Vernadakis, Antonia; Curry, John J.; Maletta, Gabe J.; Irvine, Georgia; Timiras, Paola S. (Univ. of California, Berkeley). Exp. Neurol., 16: 57-64(Sept. 1966).**

To examine effects of radiation on functional development of the central nervous system (CNS), responses to maximal electroshock and direct spinal cord stimulation were studied in the offspring of rats x irradiated with 100 R at 14 days of gestation. The full tonic-clonic seizure characteristic of adult rats occurs in normally developing rats no later than the twenty-first day after birth; the time of appearance of this maximal seizure pattern is a sensitive indicator of CNS functional development. Spinal cord convulsions can be elicited by direct spinal cord stimulation in 1-day-old rats. The time of appearance of the maximal seizure pattern and the durations of its components were studied between 1 and 59 days after birth. The full tonic-clonic seizure pattern appeared in 50% of irradiated animals at 16 days after birth, 2 days earlier than in controls. Duration of spinal cord convulsions elicited by direct electrical stimulation of the spinal cord were also studied in control and irradiated rats. In both maximal electroshock seizures and spinal cord convulsions, the durations of flexion were generally shorter and the durations of extension generally longer in irradiated animals than in controls. It is concluded that prenatal x irradiation increases the intensity of seizure activity in rats during development. The threshold of some neuronal elements may be lowered by irradiation because of destruction of incoming inhibition to those elements. Additional evidence that the development of inhibitory elements in various CNS areas might be altered by irradiation has been found with the use of drugs known to act selectively on excitatory or inhibitory systems. For example, early postnatal x irradiation lowers the convulsive dose of strychnine in developing rats, reflecting a decreased inhibition. It is suggested, therefore, that as a result of a decrease in inhibition, the threshold of response of excitatory elements to stimulation is lowered. (BBB)

8956 INTERACTION OF LASER RADIATION WITH ORAL HARD TISSUES. Lobene, Ralph R. (Forsyth Dental Center, Boston); Fine, Samuel. J. Prosth. Dent., 16: 589-97(May–June 1966).

Gross and microscopic findings of the interaction of laser radiation with human oral hard tissues, and the x-ray diffraction pattern, microhardness, and solubility of irradiated enamel, were studied. An attempt was also made to measure the temperature change in the pulp chamber of extracted teeth during laser impact. Extracted human teeth were exposed to laser radiation at a wavelength of 6934 Å and exit beam energy levels of 12 and 25 J. The lower energy produced a small crater and the higher energy a larger one. The area surrounding each crater appeared chalky white with glasslike fusion of the surface enamel. Diameters of the craters at the surface ranged from 0.8 to 1.1 mm, and that of the areas of glasslike fusion from 1.7 to 2.1 mm. A laser beam with an exit energy of 25 J focused on cementum produced a crater of 0.9 mm in dia surrounded by a blackened area 8 mm in dia. The effect of laser beams on enamel was observed microscopically as a cone-shaped crater produced at the point of impact. Adjacent to this crater, a zone showing alteration of the enamel rod structure extended from the apex of the crater to the surface enamel. No change was found in the radiodensity of enamel adjacent to the craters. Also, there was no change in the hydroxyapatite configuration of enamel isolated from the surface enamel surrounding the craters, and no change in microhardness of laser irradiated enamel. Alterations in the enamel rod structure in the area of laser impact observed with the light microscope and in birefringence of this enamel as seen in polarized light suggest a disruption of the patterns of enamel rods. The coating of the enamel surface with dyes modified the interaction of laser radiation with enamel. (BBB)

8957 EXPERIMENTAL PULMONARY SCLEROSIS FROM γ RAYS. I. SEROLOGIC AND MORPHOLOGIC FINDINGS. Corinaldesi, A.; Mancini, A. M.; Rimondi, C.; Tison, V. (Univ., Bologna). Boll. Soc. Ital. Biol. Sper., 41: 799-802(July 31, 1965). (In Italian).

Adult rabbits were subjected to ^{60}Co γ irradiation over a thoracic field of 5 × 5 cm in daily doses of 700 rad for a total dose of 4900 rad. Some of these rabbits received four months later a local dose of 1000 rad daily for 5 days. After the first course of irradiation, serum α-globulins, examined by paper electrophoresis, declined in 7 out of 8 animals; after the second irradiation period α-globulins rose slightly in 4 out of 6, remaining below the basal value. β-Globulins rose after the first irradiation and fell after the second. γ-Globulins followed the changes seen with α-globulins. Macroscopically, the lungs appeared congested and, histologically, periodic acid-Schiff staining substances were increased. The pulmonary tissue was diffusely infiltrated with lympho-histiocytic cells and eosinophils. Incipient fibrosis was evident. Vascular swelling was present. Sclerosis was more pronounced after a second course of irradiation. This was preceded by inflammatory changes and increase of reticulum. (BBB)

8958 NOTE ON FURCHTGOTT'S BEHAVIORAL EFFECTS OF IONIZING RADIATIONS: 1955–61. Garcia, John (Massachusetts General Hospital, Boston); Buchwald, Nathaniel A. Psychol. Bull., 61: 234-5(1964).

The review of Furchtgott (Psychol. Bull., 60: 157-99 (1963)), relating to effect of radiation on behavior, is commented on and some supplementary data, particularly concerning results with very low doses of radiation, are provided. A total dose of 10 R delivered over 4 hr could be employed as an unconditioned stimulus to establish avoidance responses in rats. This means that the adult animal is more radiosensitive than had been previously believed on the basis of physiological as well as histological examinations. Arousal properties of x rays in mammals also demonstrates their use as a conditioned stimulus (CS). In sleepy animals x rays produce immediate electroencephalographic desynchronization, as well as behavioral arousal. (TSS)

8959 DESTRUCTION AND RECOVERY OF RADIOSENSITIVE TISSUES. STUDY OF TIME FACTORS. **Jolles, B.; Harrison, R. G. (Hopital General de Northampton, Angleterre, France). J. Radiol., Electrol. Med. Nucl., 47: 547-53(Oct. 1966). (In French).**

Work is described on the influence of general factors and site of involvement in the destruction and recovery of radiosensitive tissues. It is emphasized that the components of the inflammation reaction be considered fully in view of the total complex if an adequate reaction is to be obtained. It is suggested that radiation effects may be potentiated by the tissue volume unaffected by spatial fragmentation (grid method) or by adequate time fractionation based on the time interval required for recovery of radiosensitive tissues. The possible role of enzymatic activation and inhibition was investigated with respect to the phenomena described, and the close relation between tissue response to irradiation and immunological phenomena is discussed. (tr-auth)

8960 BEHAVIOR OF MALIGNANT CELLS TO RADIATION THERAPY IN CARCINOMA OF THE ORAL CAVITY. Sundaram, K.; Rijhsinghani, K. S. (Atomic Energy Establishment, Trombay, India). Indian J. Med. Sci., 14: 201-4(Mar. 1960).

Cytologic changes were examined in 10 cases of cancer of the oral cavity followed by different periods of deep irradiation. The pretreatment cytology in all these cases revealed a similar picture but the response to radiation varied. Three cell types which showed differences in nucleolar RNA content are described. The cytoplasm of these cells generally manifests an excessive accumulation of RNA. Malignant cells with a minimum of nucleolar RNA which are present in the pretreatment smears were completely absent following deep x-irradiation, demonstrating the effect of inhibition of mitosis following ionizing irradiation. Persistence of cells with well-marked nucleolar RNA even at the end of treatment, i.e., 4200 R of deep x rays, is indicative of an inadequate cytological response. Seven cases revealed this picture and 6 of these cases had a recurrence of the growth within a few months after therapy. This cytologic method is considered useful in evaluating the chances of curability of malignant neoplasms. (BBB)

8961 LASER IRRADIATION OF THE SKIN. Klein, Edmund; Fine, Samuel; Laor, Yona; Litwin, Martin S.; Donoghue, John; Simpson, Lenore (Roswell Park Memorial Inst., Buffalo). J. Invest. Dermatol., 43: 565-70(Dec. 1964).

A ruby crystal laser operating at a wavelength of 6943 Å and at energy levels of 3 to 100 J per pulse (pulse duration 1 msec) was used to determine the effects of laser irradiation on mice skin and its underlying structures. Irradiation of the skin of intact mice produced a plume of back scattered radiation (and particulate matter) that contained components which differed from the primary incident radiation. At energy levels of 40–50 J per pulse, ~50% of the incident energy was transmitted through the cutaneous layer of the abdominal wall; 25% of the incident energy was transmitted through the entire abdominal wall. A linear relationship between incident energy and transmitted energy was not established. Superficial lesions produced by irradiation of the skin of intact animals were considerably more severe than those produced in isolated skin flaps. Severe lesions were observed deep in the abdominal and thoracic viscera at the site of the laser irradiation. Slight morphological changes in the epidermis and dermis were accompanied by marked damage and hemorrhages in the muscle layers. Application of heat to intact and isolated skin preparations by means of a cautery needle resulted in lesions similar to those produced by irradiation. However, laser irradiation lesions were more severe than those of heat application and the effects observed could not be attributed solely to conduction of heat. Irradiation of Harding-Passey melanoma at energy levels exceeding 350 J per pulse resulted in lasting regressions in 13 of 18 animals. In seven of 15 animals, with two or more nodules of melanoma, irradiation of one nodule resulted in lasting regressions of the nonirradiated as well as the irradiated tumors. (B.H.S.)

8962 INCIDENCE OF LEUKEMIA IN HIROSHIMA DURING THE YEARS 1946 TO 1962. Watanabe, S.; Takizawa, Sh.; Yokoro, K.; Hirose, F. (Hiroshima Univ.). Israel J. Med. Sci., 1: 787 (July 1965).

A survey was made on the prevalent types of leukemia among survivors of the atom bomb explosion in Hiroshima. The survey provides complete figures for the years 1946 through 1962. Although the incidence of leukemia is still prevalent among the Hiroshima survivors, it has gradually declined during the last few years. Chronic myeloid leukemia was strikingly predominant among these leukemia cases. An increased incidence of leukemia among individuals who entered the city shortly after the explosion was also found; the character of these cases appeared to be similar to that of the directly exposed cases. A majority of these leukemia cases were found in individuals who entered the city within three days after the explosion. (BBB)

8963 BLOOD DISORDERS AS RADIATION HAZARDS. Watanabe, Susumu (Hiroshima Univ.). Israel J. Med. Sci., 1: 677-90 (July 1965).

A review of hematological disorders that appear as sequelae from exposure to ionizing radiations was taken from data on survivors of the atomic bomb in Hiroshima. Disorders that have been observed among atomic bomb survivors were compared to known sequelae of irradiation in man and experimental animals. Out of 303 leukemia cases that developed in Hiroshima during the past 18 years, 190 were from the population that was exposed less than 5 km from the hypocenter. The death rate from leukemia per 100,000 persons per year during this period was found to be 4.22, whereas that of exposed cases was 9.98. The mean value for Japan during the same period was 2.03. An increased incidence of the disease was also noted among those who entered the city early and among those who stayed for certain periods of time shortly after the explosion. In early entrants who were exposed to prolonged, internal total-body irradiation, the incidence of chronic myeloid leukemia was high. In contrast, the majority of leukemias induced in persons from radiotherapy were of the acute myeloid form. In patients with ankylosing spondylitis that were treated with x rays and in children that were treated with x rays for enlargement of the thymus gland, acute myeloid leukemia was found to be the predominant form. The mechanism involved in the development of radiation leukemogenesis was discussed. (BBB)

8964 CHANGES IN SEMEN AND BLOOD OF BOARS FOLLOWING TOTAL-BODY GAMMA IRRADIATION. Pace, H. B. (St. Louis Coll. of Pharmacy); Hupp, E. W.; Murphree, R. L. J. Animal Sci., 21: 615-20(Aug. 1962).

Fifteen Hampshire-Yorkshire-Duroc crossbred boars were assigned to the following treatment groups: (1) control, (2) 200 R, and (3) 400 R (air dose) total-body ^{60}Co γ irradiation. Semen was collected from each boar at weekly intervals for 26 weeks after irradiation to measure total sperm output. Semen was evaluated on the basis of: (1) volume, (2) total sperm, (3) rate of motility and percentage motile sperm, (4) percentage abnormal sperm, (5) initial fructose concentration, (6) fructose utilization during a 90-min aerobic incubation period, and (7) oxygen utilization during a 75-min incubation period. Numbers of sperm per ejaculate in treated boars were reduced at 7 weeks, reached a low point at 9 weeks, and returned to within the control range by 14 weeks after irradiation. One boar in the 400-R group failed to show any recovery in sperm production by 7 months but was producing about 50% as many sperm as the others by 14 months after irradiation. With the exception of this boar, semen characteristics of the three groups did not differ during the 14-day daily collection period. Oxygen utilization was depressed the 5th through 12th weeks after irradiation; motility was depressed the 7th through 11th weeks and percent abnormal sperm increased the 6th through 9th weeks. White blood cell concentration was depressed immediately after radiation, reached a low point at 4 days, then began a slow recovery, but had not returned to normal by 200 days; platelets dropped immediately after irradiation, reached a low level at 14 days, then returned to normal by 42 days after irradiation. Except for the time scale, the effect of a single sub-lethal dose of radiation appears to be similar in the boar, bull, dog, rabbit, rat, mouse, and man. There is an initial period in which no effects on the semen are apparent, then a period of decreased semen quality which may result in sterility followed by apparently complete recovery. (BBB)

8965 SOME EFFECTS OF LASER IMPACTS ON EXTRACTED TEETH. Gordon, Thomas E. Jr. (Orange Memorial Hospital, Orlando, Fla.). J. Dent. Res., 45: 372-5(Mar.–Apr. 1966).

Effects of laser radiation on the tissues of extracted human teeth were determined with a synthetic ruby laser emitting a wavelength of 6943 Å and an exit energy of 50 J. The laser wavelength was focused to a 1-mm spot with an energy density of 12,600 J/cm^2. Observations were made on the cutting of tooth structures and photographic records of the impact events were made. A prime observation of the impact event was the high-velocity ejection of a plume of intensely luminescent material from the impact area; the plume was composed of vaporized tooth structures in an ionized state. The yellow-white photocolor of the plume indicated that probable plume temperature was in the area of 3000°K. Observations revealed that radiation other than the incident laser radiation was emitted on impact with the tooth. Color photographs disclosed that the crown enamel glowed intensely with a yellow-green to white luminosity and that root surfaces emitted red light which illustrated that the enamel emitted light from self-luminosity and that root illumination was from transillumination. Occlusal impact was shown to create a much greater luminosity of the tooth structure than smooth surface impacts. These data illustrated that laser radiation stimulated certain biological tissues to self-radiation or bioluminescence at frequencies other than that of the incident radiation. (B.H.S.)

8966 INCIDENCE OF LETHAL DEVELOPMENTAL DEFECTS AND NUMBER OF X-RAY EXAMINATIONS. Garay, G.; Szederkenyi, Gy (County Council Hospital, Kecskemet, Hung.). Acta Morphol. Acad. Sci. Hung., Suppl. 13: 42(1965).

The infantile death rate from developmental defects in the period 1956 to 1962 was compared with the number of x-ray examinations performed in the same area during the same period. The number of x-ray examinations and the incidence of developmental abnormalities causing death in infancy were found to exhibit a parallel increase (by 20 and 40%, respectively). A causal relation is presumed to exist between the two figures. (BBB)

8967 THE HEMATOLOGICAL EFFECTS OF 14.1-MeV NEUTRONS IN MICE. Kamochi, Yasuro; Ozono, Noboru; Tanaka, Nobuo; Ito, Kazuro; Kamata, Nanao; Okada, Kosuke (Hiroshima Univ.). Nippon Katsueki Gakkai Zasshi, 27: 475-81(Aug. 1964). (In Japanese).

The effects of single dose of 14.1-MeV neutrons, produced by the T(d,n)He reaction, on the blood of mice were compared with those caused by x irradiation at 180 kvp. Female ddN mice, 10 weeks of age, were exposed to single dose of 50, 150, and 400 rad of fast neutrons or x rays. The mice were examined for changes in various hematological parameters at 3, 10, 20, and 40 days after irradiation. The neutron irradiation strongly depressed bone marrow hematopoiesis, with the delayed recovery, as compared with x irradiation. In both cases, however, the megakaryocytes were affected to a similar degree. Hematocrit values, red cell counts, and hemoglobin content of peripheral blood were kept at low levels for a longer period after neutron irradiation as compared with those after x irradiation. Responses of granulocytes and agranulocytes in circulating blood to neutron irradiation were similar to those after x irradiation. With neutron irradiation, spleen and thymus weights fell more markedly than with x irradiation. The weight of thymus after neutron irradiation recovered with the same time lapse as that seen with x irradiation, but recovery of the weight of spleen after neutron irradiation proceeded without the second weight loss observed after x irradiation. The delay in bone marrow regeneration after neutron irradiation suggests qualitative as well as quantitative differences between neutrons and x rays in their depressant action on hematopoiesis.(BBB)

8968 LASER: A NEW TYPE OF RADIATION SOURCE. Keck, Gertrud (Tieraerztliche Hochschule, Vienna). Wien. Tieraerztl. Monatsschr., 52: 711-22(1965). (In German).

The laser has found use in treatment of retinal detachment since it produces coagulation with 0.001 sec as compared to 0.5 sec with a Xe source, so that eye movements cannot disturb the treatment. In addition, the short coagulation time prevents necroses that may occur on the retina. The energy of the laser beam is controlled by a calorimeter built into the photocoagulator, so that coagulation can be carried out more homogeneously. The laser also provides an opportunity to treat tumors of the retina without surgery. Conditions for treatment of the retina are very favorable because the optical tissues of the eye are entirely transparent to the ruby laser beam and do not require additional focussing of the beam. The pigmented retina absorbs the light very well. However, the eye must be protected against the reflected beam. Damage to the retina may occur at 0.04 J energy. Skin exposed to the ruby laser beam absorbs ~80% of the incident energy within the first two mm, so that internal tissues and organs are unaffected. Laser effects have been observed in erythrocytes, where the hemoglobin probably was coagulated. A strong electrical field is probably produced in a molecular layer surrounding the point of coagulation. (BBB)

8969 SOME PROBLEMS IN THE USE OF LASER IN PHOTOCOAGULATION OF THE RETINA. Blabla, J.; John, J.; Jelinkova, A.; Vendl, J. (Inst. of Radiotechnology and Electronics, Prague). Cesk. Ophthalmol., 21: 281-91(July 1965). (In Czech).

Principles of generation of laser beams, instrumentation, and medical applications are considered, with emphasis on preventing injuries with their use. Biological effects of laser energy were studied using the rabbit eye as a model for clinical studies on photocoagulation of the retina. Physiologic and morphologic changes in rabbit retinal tissue from the use of a ruby laser are described and illustrated. An optical system for use with the laser source was devised which provided maximum safety features to protect the user. This system was equipped with a mirror arrangement coupled with the ophthalmoscope so that electrical contact for the laser light source was automatically interrupted when the operator's eyes could be exposed to the beam. Experiments were conducted to determine the level of energy needed to produce optimal photocoagulation in the retina. (BBB)

8970 TISSUE HEALING AND INFECTION IN EXPERIMENTAL ANIMALS IRRADIATED WITH ^{60}Co AND ORTHOVOLTAGE. Meyer, Irving; Shklar, Gerald; Turner, John (Tufts Univ. School of Dental Medicine, Boston). Oral Surg., Oral Med., Oral Pathol., 21: 333-40(Mar. 1966).

A major clinical problem following radiation therapy for oral cancer in human beings is development of osteoradionecrosis in the mandible or maxilla. Studies were conducted in rats to compare the induction of this process by 200-kv x rays and ^{60}Co γ radiation. Two weeks after exposure to local mandibular doses of 1530 R, surgical processes were instituted to simulate human clinical conditions. Tissue healing proceeded normally in animals irradiated with telecobalt but was retarded in animals irradiated with a comparable dose of standard 200-kv radiation. There was a minimal epithelial response to ^{60}Co radiation, whereas marked epithelial degeneration was found following exposure to a similar high dose of conventional x radiation. Infection was not a significant finding. Following exposure of the incisor dental pulp by clipping of the teeth, severe inflammation with abscess formation did not occur in the control group or in either radiation group. Osteoradionecrosis did not occur following pulp exposure in the radiation groups, nor did it occur following exposure of the alveolar bone by gingivectomy. In the orthovoltage radiation group, where gingival healing was delayed, several rats did develop gingival abscesses. Although an attempt was made to deliver an equivalent tissue dose of 1530 R from the two different modalities, the difference between roentgens as a measure of delivered dose and rads as a measure of absorbed dose was considered. For an equivalent biologic effect, it was found necessary to have a 10% greater dose in supervoltage rads than that calculated for orthovoltage rads. (BBB)

8971 THE LASER AND ITS USE IN RETINAL SURGERY. Tengroth, Bjoern (Univ. Eye Clinic, Gothenburg, Sweden). Acta Ophthalmol., 44: 135-41(1966).

Physical principles in the generation of laser radiation are explained, its biological effects, especially on the eye, are described, and its use in retinal coagulation is considered. Because of the directivity and energy density the laser beam can be concentrated to small areas by means of an ordinary optical system. In this way the laser can be used, among other applications, as a coagulator in retinal surgery. Light coagulation in retinal surgery has hitherto been applied by means of a xenon lamp source. The dimensions of such a light source are very large, and its use in optical systems is therefore limited. The use of a laser as a light source for light coagulation provides the ophthalmologist with a useful tool, as the whole instrument can be built into an ordinary ophthalmoscope. The results are promising but further studies are necessary to evaluate this new coagulator. The resulting coagulations are smaller and deeper than with other instruments. Up to now no special tissue injuries have been noted but it cannot be excluded that changes may develop that are solely a function of the coherence. Using a so-called Q-switched laser where one of the coated end surfaces of the crystal has been replaced by a rotating re-reflecting prism, the resonance cavity is established for a very short time. This means that the laser beam leaving such a crystal is very short and therefore includes less energy. However, the exposure time can be measured down in the nanosec range and the power density in such a pulse can be enormous, especially if the light is focussed on a very small area. Power densities of the order of Mw/cm^2 and Gw/cm^2 can then be obtained, resulting in a tissue explosion. This means that the exposure times have to be carefully taken into consideration in laser coagulation. The exact nature of this tissue damage is still unknown. (BBB)

8972 EFFECT OF DIVIDED X-RAY IRRADIATIONS UPON THE PERCENT SURVIVAL AND ORGAN WEIGHTS OF MICE. Ueno, Yori (Kyoto Univ.). Nippon Igaku Hoshasen Gakkai Zasshi, 26: 356-60(July 1966).

Radiosensitivity effects of dose fractionation were studied in mice given conditioning and challenging doses of x rays. Weights of spleen, thymus, liver, and testes in survivors and percent survival were used as indices of radiosensitivity. Fluctuations were observed in the pattern of recovery of normal radiosensitivities by the animals. (H.G.D.)

8973 ROENTGEN RAYS, MUTATIONS, AND MALIGNANT TUMORS. de Waard, R. H. (Univ., Utrecht). Jaarb. Kankeronderz. Kankerbestrijding Ned., 13: 127-32(1963). (In Dutch).

Theory on the interrelation of mutagenic and carcinogenic effects of ionizing radiation and several speculative concepts of radiocarcinogenesis are discussed. The report dealt with some aspects of the hypothesis that states that the origin of radiation-induced tumors may be traced to somatic mutations and pointed out that radiation induced tumors cannot originate from a single mutation (A) in a normal cell, since tumor frequency would be proportional to the dose applied; this is contrary to observed facts. The report points out that, if one were to assume that a tumor would only develop when two mutations A and B occur in the same cell, then this objection has been overcome and a bimutational hypothesis of carcinogenesis has been justified. It was shown how the hypothesis is in line with Berenblum's two-stage theory and how it explained the following fundamental facts: (1) Mitotic division of malignant cells causes new malignant cells, even when their malignancy is the result of some carcinogenic agent that is no longer present; (2) to be effective, carcinogenic agents need a long period for stimulation; (3) malignant tumors usually originate in altered tissues. Non-malignant alterations were attributed to single mutations. (BBB)

8974 RESPONSE RATE DURING X IRRADIATION AND RECOVERY FOLLOWING IRRADIATION. Brown, W. Lynn (Univ. of Texas, Austin). J. Genet. Psychol., 108: 117-20(Mar. 1966).

An examination of the decrement in response rate and recovery response during irradiation was conducted with Sprague-Dawley rats. Post irradiation the rats were trained until the response rate reached ~1200 responses/hr on a 20-1 reinforcement schedule. They were then x irradiated at 100 R/hr daily or 300 R/hr on days 3, 6, 9, and 12. The total dose was 1200 R. At the termination of each three-day period during irradiation, both the 100-R/hr animals and the 300-R/hr animals had accumulated the same total dose. The principal performance discrepancy during the irradiation period was seen in the 300-R group, which showed recovery of decreasing amounts after each irradiation, while the 100-R per-day group declined steadily. These differences were analyzed by a comparison of the trends in the two groups as the interaction of groups by days 0, 3, 6, 9, and 11 (when the groups had equal cumulative doses). These days also corresponded to the peak of recovery in the 300-R group, i.e., the day on which testing was followed by irradiation of this group. This trend difference, a negatively accelerated decline in the 100-R group as opposed to positive acceleration of the decline in the 300-R group, was significant. The 100-R/day animals showed a rapid and regular decay in response nearly linear in form until an asymptote was reached near zero on day 7. Rats exposed to 300 R at three-day intervals showed an irregular overall decline in response rate with increases on the second and third days following the first two exposures. There was a rapid recovery of response rate in the 100-R subjects after irradiation was discontinued on the twelfth day. This recovery was not observed in the 300-R rats. (BBB)

8975 PATHOMORPHOLOGIC CHARACTER OF INFLUENZA INFECTION IN IRRADIATED AND IMMUNIZED MICE, TREATED WITH MARROW. Maksimovich, N. A.; Lebedeva, O. P. (Inst. of Contagious Disease, Ministry of Public Health, Ukrainian SSR). Dokl. Akad. Nauk SSSR, 166: 469-71(Jan. 11, 1966). (In Russian).

Whole-body x-irradiated (600 R) mice were treated with bone marrow 1 hr after the irradiation and were then vaccinated against influenza. About half of the 200 animals died within the first 28 days, and the surviving half were then exposed to influenza virus. Histological examination showed that the combined effect of irradiation, treatment with bone marrow, and vaccination produced a sharp change in the reaction of the organism. Instead of the usual regeneration of damaged epithelium, there was excessive growth of it, to some degree like that in a malignant condition. The serious interference with the breathing mechanism that resulted from this was one of the chief causes of death in the animals that were subsequently infected with influenza virus. Half-tones of histological sections and of an electron-microscope photograph are presented. (TTT)

8976 EXPERIMENTAL STUDIES OF SYNCARCINOGENESIS. V. STUDIES OF THE PRODUCTION OF CANCER IN RATS BY SIMULTANEOUS TREATMENT WITH X RADIATION AND DIETHYLNITROSAMINE OR 4-DIMETHYLAMINODIPHENYL. Schmaehl, D.; Stutz, E.; Thomas, C. (Deutsche Krebsforschungszentrum, Heidelberg). Z. Krebsforsch., 68: 68-72(1966). (In German).

Rats were irradiated with 320 R of 180-kv x ray when they were 90 ± 3 days old, 24 hr before administration of the chemical carcinogens. The diethylnitrosamine was administered at 3 mg/kg in the drinking water, and the 4-dimethylaminodiphenyl was fed to the animals at a rate of 0.86 μg/kg. The median life expectation of the control animals was 714 days, while that of animals given the treatments was 500 to 637 days. Non-malignant tumors, consisting of fibromas of fibroadenomas of the mammae, or rarely skin basiliomas, appeared in all groups. All rats treated with diethylnitrosamine developed hepatocellular carcinomas after cumulative doses of 690 ± 53 mg/kg. A similar result was observed in animals that had been irradiated and treated with this substance after a cumulative dose of 674 ± 45 mg/kg. No syncarcinogenic action was detectable. Incidence of tumors in animals given 4-dimethylaminodiphenyl was 23% as compared to 7% in controls, and increased only slightly to 29% when combined with irradiation. The tumor incidence with irradiation alone was 28%. Irradiation was not syncarcinogenic for either of the carcinogens used. The results suggested that syncarcinogenesis could be expected only if the substances used affected similar organs or cells. (BBB)

8977 EFFECTS OF X RAYS ON CELL LETHALITY AND MICRONUCLEAR NUMBER IN THE CILIATE SPATHIDIUM SPATHULA. Williams, Donald B. (Oak Ridge National Lab., Tenn.). J. Protozool., 13: 272-7(May 1966). (ORNL-P-1273).

Responses of S. spathula to high doses of x rays, ranging up to 55 kR, were studied with primary emphasis on long-lasting injury (lethality, monster formation, and changes in micronuclear number). The ciliates showed one or more of the following kinds of behavior: (1) Death of an individual cell (primary death); (2) death of a descendant of an irradiated cell (secondary death); (3) permanent injury including one or more of the following: low daily division rate, excessive macronuclear enlargement, total loss of micronuclei, cytostome replication, heavy pigmentation, and decreased motility; (4) temporary division retardation for 1 to 2 days followed by apparent complete recovery; and (5) no apparent injury. The first 3 kinds of behavior increased with increasing dosage from 15 to 55 kR. At 6 kR only the last 2 categories were observed. The LD_{50} for 8 days was 46 kR for both primary and secondary death, or 60 kR for primary death alone. Micronuclear number varied greatly following irradiation in lines showing either permanent or temporary injury. Two different responses occurred: (1) The micronuclear number averaged about twice the normal number of 20 with a large range (9 to 360) one day after exposure. The number gradually decreased during the next two days; (2) some cells lost all micronuclei following irradiation, the incidence increasing with dose. At 55 kR, complete loss of micronuclei occurred in 96% of the surviving lines. Micronuclear loss may be the result of injury not to the micronuclei directly, but to some system whose integrity is necessary for maintenance of the micronucleus. The disturbance of the cell cycle which causes production of extra micronuclei might also be responsible for extra macronuclear DNA synthesis. Because cell division is suppressed while feeding continues, giantism is the consequence. Heavily irradiated cells contain abnormal micronuclei that are wedge- or spindle-shaped, suggesting massive micronuclear injury. Some micronuclear loss may result from failure of daughter micronuclei to be passed to daughter cells. (BBB)

8978 EARLY BEHAVIORAL EFFECTS OF WHOLE-BODY EXPOSURE TO X RAYS. McDowell, A. A.; Brown, W. Lynn (Univ. of Texas, Austin). J. Genet. Psychol., 108: 109-15(Mar. 1966).

Forty 4-yr-old rhesus monkeys received whole-body exposures of 400 to 800 R of x rays. Behavioral categories observed included nondirected visual activity; nondirected locomotor activity; manual, oral, and visual response to the subject's body parts; manual, oral, and visual response to the cage parts as manipulanda; visual response to the experimenter; and orientational response to noises outside the laboratory. Each monkey was observed before and after the first hour of actual and sham exposure. A second study was based on the minimum response latencies. The third study involved the discrimination of a white card holding a centered black dot from a blank white card. Results showed a depression in locomotor activity accruing to radiation exposure, and indicated that the threshold to profound depression lies between 400 and 500 R. The data showed an increase in minimum response latency accruing to radiation exposure and indicated, that the threshold to profound effect lies between 400 and 500 R. The higher the relative radiation dosage, the greater is the proportion of monkeys that balked on the dot-discrimination problem. These results, of decreased locomotor activity, increased minimum response latencies, and decreased motivation to respond on a dot-discrimination-problem during the first hour after exposure to x rays, are possibly of little significance other than indicators for radiation sickness. Threshold to such sickness falling between 400 and 500 R should be of importance to radiation research and in the treatment of radiation sickness. (BBB)

8979 GROWTH OF J SARCOMA IN MICE SUBMITTED TO SINGLE WHOLE-BODY IRRADIATION AND TREATED BY BONE MARROW. Booz, G.; Betz, E. H. (Univ., Liege). Bull. Ass. Franc. Etude Cancer, 52: 349-58(Oct.-Dec. 1965). (In French).

Female C57B1 mice were injected with cystamine (100 mg/kg) before x irradiation with 800 R. After irradiation they were injected with isologous bone marrow suspension. At 24 hr post-irradiation some mice were implanted with small fragments of J sarcoma in the abdominal skin. Spontaneous regression of tumor (in control mice) averaged 40% and lymph node dissemination of the tumor in controls was rare (~1%). In mice which received a lethal radiation dose plus cystamine protection, tumor regression was ~10%, with a slight increase of lymphatic dissemination (5%). In mice irradiated and protected with marrow, no regression of tumor occurred and lymphatic spread reached 80%. Cystamine plus marrow protection gave results similar to those seen in mice administered only cystamine: 10% regression and 0% lymphatic spread. With injection of spleen cells after irradiation, no regression of tumor occurred, but lymphatic spread was only 20% (compared with 80% in marrow-treated mice). The results of histologic studies indicated the cystamine protects plasma cells and thus permits an immunologic response against the invading tumor cells, whereas bone marrow transplantation did not appear to enhance the development of plasma cells and the immune response. (BBB)

8980 LASER INTERACTIONS WITH EXTRACTED HUMAN TEETH: A PRELIMINARY REPORT. Gordon, Thomas E. Jr. (Orange Memorial Hospital, Orlando, Fla.). Dent. Digest, 72: 154-8(Apr. 1966).

A graded series of impacts was done to ascertain a threshold of interaction between the laser beam and tooth enamel. Below a critical level for interaction between the beam and enamel a dark spot surrounded by a luminous, irregular area was revealed when photographed. It is suggested that the luminosity surrounding the dark spot is a reaction of the tooth structure in a stimulation of fluorescence by the calcium in the enamel. Ionization of the calcium may occur to a single ionized state. A ground state resonance of the calcium atom exists at 4226.7 Å, as well as two lines at 3933.7 and 3968.5 Å, among others. Since the film registers a light violet at this level of intensity, it is believed that there may be excitation and ionization of the calcium by the incidental energy. Impact occurred at the point of focus and was seen at an energy density of 1000 J/cm^2. This is called the critical reaction level since vaporization of the enamel did not occur at a lower level. No grossly visible tooth material was removed by this impact. With progressively greater vaporization, the plume thrown out by the impact is self-luminous and ionized, having a bright line emission spectrum. Line reversal occurs in three lines of calcium, one singly, and two doubly ionized. Reversal of sodium D lines is also present. The glow of surrounding enamel increases as the impact energy level increases. A highly charged ionized area is probably present at the impact site as shown by the odor of ozone, spectrographic analysis of the plume, and an air glow photographed at higher energy levels. A still greater plume was ejected from a 20-J impact site. With an impact of 75 J the intense luminosity of the enamel is evident as well as a violet air glow typical of air ionization. All pulsed impacts are accompanied by a shock wave which is more noticeable on the tooth than that of a metallic impact. The loudness of the crack of the shock wave varies directly with energy impact. However, it should cause no pain to the patient since pulse length is only 2–3 msec for a normal pulse and stimulation for around 200 msec is required to cause pain sensation. (BBB)

8981 LASER-INDUCED MICROPERFORATIONS IN TEETH SECTIONS. Kinersly, T.; Jarabak, J. P.; Phatak, N. M.; DeMent, J. (Univ. of Oregon, Portland). J. Dent. Res., 45: 199-203(Jan.-Feb. 1966).

The relative effects of laser light on various parts of teeth were studied. The ruby laser used emitted coherent light at a wavelength of 6943 A (deep red) and at an energy output of 0.1 to 0.6 J. Samples tested were sections of human bicuspids. Microperforations at varying input energy levels were made in 100-μ thick ground sections. Energy levels sufficient to cause holes in enamel did not always produce holes in dentin. The effect of varying energy levels on varying thicknesses of samples is shown. Microperforations appeared in thicknesses up to 0.6 mm at higher energy levels. The effect of varying the focus on 0.5-mm thick sections is shown. Holes were most consistently produced and of greatest dia when the focus was slightly internal to the surface first contacted by the laser beam. Varying the magnification was also tested. After about three laser beam transmittances, the microscope objectives displayed temporary fogging or permanent pitting of the front lens surface. Also, internal thermal effects on the lens cement seemed to be produced. The effect of adding a stain complementary in color to the laser light was also examined. In contrast to earlier results, microperforations in dentin not only were consistently produced, but were greater in dia than those in enamel after 24 hr of soaking in the more highly concentrated stain solutions. Results showed fair reproducibility of hole dia in sections of human teeth after low-powered ruby laser beam impact, dependent on beam energy, target material and thickness, focus, magnification, working distance, and added stain concentration. (BBB)

8982 STUDIES WITH RUBY LASER RAYS ON ANIMAL AND HUMAN TISSUES. Flach, A.; Geisbe, H.; Schulte, W.; Mueller, G. Arch. Klin. Chir., 313: 975-7(Dec. 20, 1965). (In German).

Effects of ruby laser irradiation of soft tissues, including skin, musculature, and liver of guinea pigs, and hard tissues such as extracted human teeth and guinea pig bones in situ were studied. In single pulse operation the irradiation energy was 45 J, and in multiple pulse operation at 15/sec the energy was 2.5 J. Basically, tissue trepanation is possible with the ruby laser, but the effect on the various tissues varied considerably. The elasticity and the color of the tissue were important factors. The monochromatic red light of the laser was reflected by red-colored tissues, but it was absorbed by the yellow-brown hard tissues, such as bone and teeth. Stained tissues and melanotic cells markedly absorbed the rays. Brown-black caries material and dark-colored dental fillings were selectively removed by the laser irradiation. The assumption that a microexplosion takes place at the point of impact of the laser seemed justified. A combined thermomechanical destructive event was suggested by the scattering of tooth particles. However, it is also possible that the energetic photons had a purely mechanical shock effect. Practical uses for the laser are still incompletely developed. (BBB)

8983 LASER EFFECTS ON TISSUE AND MATERIALS RELATED TO DENTISTRY. Kinersly, T.; Jarabak, J. P.; Phatak, N. M.; DeMent, Jack (Univ. of Oregon, Portland). J. Amer. Dent. Ass., 70: 593-600(Mar. 1965).

The literature concerning the biological effects of laser radiation is reviewed, and effects of laser radiation on oral specimens and dental materials are reported. Powdered samples of enamel and dentin, calculus, and synthetic apatites showed holes or craters, depending on their thickness. Fusion was not observed in these powders singly or in various combinations with and without intact teeth. Natural and artificial stains could usually be removed from intact teeth. Eye-shielded volunteers were unable to feel heat or pain from an unfocused laser pulse of 0.5 J on the lip. When a blue stain was applied to the lip, however, and the laser beam focused on it, the volunteers unanimously reported a sudden hot sensation. The stain was ablated, and the impact area was readily visible as an off-white spot. When the excess stain was washed off, little or no evidence of the lased area was visible. Herpes simplex lesions of the lip were unaffected clinically after single exposures to the laser beam. On being lased, dental material samples were cratered; in thin samples, a hole appeared. Attempts to weld metals with the type of laser used were unsuccessful. (BBB)

8984 LASERS AND TEETH. Kinersly, T.; Jarabak, J. P.; Phatak, N. M.; DeMent, J. (Univ. of Oregon, Portland). N. Y. State Dent. J., 32: 56-8(Feb. 1966).

Effects of laser radiation on dental tissues are reviewed and speculations offered on the potential value of lasers to dentistry. Upon impact of a laser beam on a tooth, light may be absorbed, transmitted, or reflected. Absorbed light, intense enough to cause a hole in a tooth, may also cause ionization in the area of impact when the electric field strength exceeds that which holds molecules together. The probable interaction of electric field effects in the area of laser beam impact with the bioelectric potential of living tissue at present appears to be little understood. Transmitted light may not alter hard tissues, but in striking living cells, even at some distance from point of impact, may still possess enough intensity and coherence to affect metabolic processes in the cells of the pulp, periodontium, or surrounding bone. Detectable changes, such as alteration in secondary dentin formation, may be latent for many years. Reflected light may not be concentrated enough in any one spot or direction to affect oral tissues, but the eyes of operator and patient must be protected. Despite the intense heat developed at the impact spot of a laser beam, teeth do not seem to heat up significantly. Enamel and dentin are poor heat conductors. Yet, parts of the tooth may heat up and transfer considerable heat to other more heat-sensitive areas of the tooth, such as the pulp. Meager knowledge about heat effects on the pulp require caution in the use of high powered lasers on teeth. When light from a high-powered laser strikes a tooth, there is a sharp, cracking noise, similar to a miniature explosion. In addition to noise, there are hot vapors and finely scattered matter (partly ionized) which plume back out of the suddenly produced hole; also, there is a shock wave partly associated with the ejected material and partly absorbed by the tooth. (BBB)

8985 IMMUNOLOGICAL REACTIVITY AND BLOOD PICTURE IN RATS AFTER A SINGLE PARENTERAL INJECTION OF SMALL DOSES OF TRITIUM OXIDE. Shalnova, G. A.; Zhuravlev, V. F. Radiobiologiya, 6: 259-63(1966). (In Russian).

Long-term observations were made of natural immunity, change in weight, and blood picture in rats given 0.01, 0.04, 0.08, 0.15, or 0.3 μCi/g doses of tritium oxide. The doses administered did not cause death of the animals during the first two months postinjection. Immunological reactivity was inhibited, and blood picture indices were increased. Escherichia coli appeared in large quantities in the mouth and the total microbial flora of the skin was increased. All effects were dose dependent. (H.G.D.)

8986 ROLE OF TRAUMA IN THE RESTORATION OF REGENERATION CAPACITY IN AXOLOTL EXTREMITIES INHIBITED BY X-RAY IRRADIATION. Tuchkova, S. J. (Severtsov Inst. of Animal Morphology, Academy of Sciences, USSR). Dokl. Akad. Nauk SSSR, 168: 473-6(May 11, 1966). (In Russian).

Axolotl were given an x ray dose of 6000 to 8000 R to the extremities and both rear legs were amputated simultaneously 20 days after the irradiation. In one series of experiments the limb was further subjected to trauma 5 times once a day starting with the second day after amputation by cutting 10 times with pincers at a depth of 10 mm. In another series of experiments the tissue was removed and replaced with finely divided muscle tissue from axolotl given a dose of 8000 R. In both series of experiments the left extremity served as a control. The data showed that regeneration was suppressed in the controls 78.5 to 100% of the cases. Necroses were observed in a number of cases. The regenerative capacity was restored in 47 to 50% of the time in two experiments after inflicting trauma on the irradiated extremity. No sores or necroses were observed. However, the results were not consistently positive. The results obtained with destruction of tissue and subsequent grafting were similar to those obtained by inflicting trauma on the extremity. The recuperative process was followed histologically. (TTT)

8987 EFFECTS OF FAST NEUTRONS ON THE ANIMAL ORGANISM. Davids, J. A. G. Atoomenergie Haar Toepass., 8: 191-9(Sept. 1966). (In Dutch).

Some factors that appear after irradiation with fast neutrons in the bone marrow and the intestinal tissue and that can be reduced to the radioinduced inhibition of cell classification processes are described. Bone marrow syndrome and the intestinal syndrome, bone marrow syndrome after neutron irradiation, bone marrow therapy after neutron irradiation, and radiation effects in root cells of the intestinal epithelium are discussed. (tr-auth)

8988 EFFECTS OF RADIATION ON LEARNING ABILITY. Schulte, John H.; Schulte, John W. (Dept. of the Navy, Washington, D. C.). Arch. Environ. Health, 13: 662-3(Nov. 1966).

The effects of ionizing on higher learning centers in rats were studied. Five rats were exposed to 200 rem of x radiation and five nonexposed rats were used as controls. Each animal was taught to run through a maze and the time required for the animal to traverse the maze was measured with a stopwatch. Five different maze configurations were designed. Each animal was permitted to run through one maze configuration until it had attained its optimum time for that maze as determined by three consecutive test runs. The tests were repeated on each animal until it had learned all 5 mazes. It was determined that there was no significant difference in the number of runs required to attain optimum

time in traversing a particular maze configuration nor in the optimum time attained between rats exposed to 200 rem x radiation and unexposed rats. It was concluded that this level of radiation did not interfere with the rat's ability to learn a maze configuration. (H.L.W.)

8989 EFFECT OF WHOLE-BODY γ-IRRADIATION ON THE STRUCTURE OF DEOXYRIBONUCLEIC ACID OF RAT SPLEEN. Cheng, Hsiu-lung; Li, Tsai-ping. Sheng Wu Hua Hsueh Yu Sheng Wu Wu Li Hsueh Pao, 5: 465-74(Oct. 1965). (In Chinese).

DNA of rat spleen was prepared by the method of Kirby & Georeyev with some modifications, DNA thus isolated from control or irradiated rats contained little RNA (less than 5%) or protein (less than 2%). The recovery was about 70%. Adult female rats were killed within 5 minutes after whole-body irradiation (200, 400, and 800 R) with ^{60}Co r-rays. The spleen DNA of irradiated rats showed no significant changes, as compared with that of control, in the following aspects: Reduced viscosity (N_{sp}/c) and UV absorption spectrum measured at room temp. before and after incubation in 0.2M NaCl at 76°C for 60 min.; temp. of heating in 1% formaldehyde solution to effect UV spectrum changes (λ_{max} and E_{max}); heat denaturation curves and "melting temp." (T_m). All these indicated that immediately after 800r of whole-body r-irradiation, the structural damage in DNA of rat spleen is not so apparent. The possibility of direct radiation damage in the macromolecular structure of DNA and the problems involved in the methods of investigation in future work were discussed. (auth)

8990 EXPERIMENTALLY PROVED CHANGES OF TOXICITY OF SOME DRUGS USED IN ANESTHESIOLOGY RESULTING FROM ACUTE IRRADIATION SICKNESS. Pokorny, Jiri (Central Military Hospital, Prague); Pospisil, Jan; Dienstbier, Zdenek. Voj. Zdravot. Listy, 35: No. 2, 50-5(Apr. 1966). (In Czech).

Fourteen substances of Czechoslovak manufacture were studied in experiments on mice. Animals react differently to a given drug, and only 95% reliability in results could be obtained. Chlorpromazine and mesocaine are quite toxic to irradiated organisms; atropine can be used in a normal way, while pethidine should be used in doses reduced by 25-30%. Thiopental is suitable even during acute irradiation sickness. Gallamine, decamethonium, and succinylcholine may be used after irradiation; tubocurarine becomes toxic. (auth)

8991 FUNCTIONAL RESPONSE OF THE CENTRAL NERVOUS SYSTEM TO LOW-LEVEL IRRADIATION. Sams, Crawford F.; Aird, Robert B.; Adams, Gail; Ellman, George; Endo, Shiro (Univ. of California Medical Center, San Francisco). Trans. Amer. Neurol. Ass., 89: 128-32(1964).

Functional response of the central nervous system of dogs to low-level x irradiation was measured by electrophysiologic changes recorded at various levels of the brain. Stainless steel coaxial electrodes were implanted in the brain of 65 beagles which received a single exposure of x irradiation delivered to the dog's head alone. Doses varied from 1 to 100 rad. Continuous recordings were made before, during, and for 4 hr after irradiation, then at 24-hr intervals for two weeks. Changes in electrical activity are described. Histopathological examination of brain sections made two weeks to four months after full recovery from the reported functional response failed to show nerve cell changes. It was not possible to correlate the EEG changes noted with observed behavior of the dogs. (BBB)

8992 ACTION OF RADIATIONS ON THE CENTRAL NERVOUS SYSTEM. II. ELECTROENCEPHALOGRAPHIC CHANGES. Abbadessa, S.; Avellone, S.; La Grutta, G. (Univ., Palermo, Italy). Boll. Soc. Ital. Biol. Sper., 41: 1412-15(Oct. 31, 1965). (In Italian).

Electroencephalographic (EEG) studies were conducted in rabbits exposed to 1000 R doses of x rays. The animals were implanted with six permanent electrodes in the cerebral cortex, bilaterally placed in the frontal, parietal, and occipital lobes. EEG recordings were made 1, 2, 4, 8, 12, and 24 hr postirradiation, typical patterns being illustrated for these intervals. In control rabbits the basic rhythm of the EEG tracing showed a frequency of 3 to 4 cps at 50 to 70 μv, on which was superimposed a fast rhythm of 15 to 20 cps at relatively low voltage (30 to 40 μv). One hr after irradiation there was an increase in frequency (to 15 to 20 cps) and voltage (120 to 150 μv) in the slow rhythm. At 8 to 12 hr postirradiation these changes were still evident, but at 24 hr these anomalies in bioelectric activity of the brain had practically disappeared. The basal rhythm had returned to 3 to 4 cps. These findings are compared with those of other authors obtained in other animal species. (BBB)

8993 RESPONSES OF THE CENTRAL NERVOUS SYSTEM TO LOW DOSES OF IONIZING RADIATION: AN ELECTROENCEPHALOGRAPHIC STUDY. Mazumdar, S. K.; Ray, S. N. (Inst. of Nuclear Medicine and Allied Sciences, Delhi). Indian J. Med. Res., 53: 1158-63(Dec. 1965).

Some recent reports have indicated changes in electroencephalographic (EEG) patterns following exposure to low levels of radiation and these have been interpreted as an expression of cortical depression by direct action of the radiation on the brain. The present study was designed to investigate the EEG changes occurring in humans as a consequence of very low doses of radiation, approaching background levels. Seven subjects received radioiodine treatment because of hyperthyroidism; two because of goiter with normal thyroid function and one because of attacks of paroxysmal tachycardia. All patients were given 2 mC of ^{131}I orally as the first treatment dose. The total dose of radiation delivered to the brain at 1 hr was calculated to be of the order of a few millirads, near background levels. In all patients, control EEG records were taken prior to the administration of radioiodine. While the EEG's were being recorded, patients were given radioiodine and the EEG recordings were continued for 45 to 60 min. Another EEG was obtained after 24 hr for possible late effects. In all patients, within 15 to 20 min following the ingestion of radioiodine, the amplitude of the background rhythm increased. The 24-hr post-treatment records, however, showed a background activity similar to that of the control tracings. Within 15 to 20 min of administration of radioiodine, the EEG of three patients showed high voltage 2- to 4-cps waves occurring isolated or in brief bursts over the parietal and temporal regions of both hemispheres simultaneously. These abnormalities were absent in the control and 24-hr records. An epileptic patient whose fits had been controlled by barbiturates showed, within 20 min from the administration of radioiodine, bursts of irregular spikes and waves over both temporal regions. These EEG changes were accompanied by clinical attacks which continued throughout the night. Thus, small doses of radioiodine may cause potentiation of cerebral electrical activity, mostly subcortical in origin, as evidenced by laterally synchronous discharges accompanied by an increase in voltage of the background activity within 15 to 45 min following its administration. (BBB)

8994 EFFECT OF SKELETALLY DEPOSITED ALPHA-RAY EMITTERS IN MAN. Evans, Robley D. (Massachusetts Inst. of Tech., Cambridge). Brit. J. Radiol., 39: 881-95(Dec. 1966).

Quantitative studies of more than 450 humans who have carried skeletal deposits of radium (^{226}Ra) and of mesothorium (^{228}Ra) for periods up to about 50 years are presented as dose v. response relationships. Several different specifications of dose and of biological end-points are compared. For residual skeletal burdens greater than about 0.5 μCi ^{226}Ra (or its rad or rad-year dosimetric equivalent of ^{228}Ra) the occurrence of osteoporosis, dense bone necrosis, trabecular coarsening, and spontaneous fracture increases with increasing residual skeletal burden and even more clearly with a dose parameter called cumulative rad-years in which increments of rad dose are weighted in proportion to the time elapsed since the incremental dose was delivered. For residual skeletal burdens from about 0.5 to 60 μCi ^{226}Ra the fractional incidence of osteogenic sarcoma and carcinoma of the paranasal sinuses or of the mastoids is about 40 per cent and appears to be independent of residual body burden. However, the tumor appearance time, or induction-plus-latent period appears to increase substantially as the residual body burden and the cumulating rad-years decreases. For sufficiently small residual body burdens the tumor appearance time may exceed the life span, thus providing a practical threshold. For residual skeletal body burdens less than 0.5 μCi ^{226}Ra no clinically significant symptoms have been observed thus far, and there is no discernible life span shortening. The initial or maximum skeletal burden exceeds the residual burden by a factor which depends upon the duration of the exposure period and is typically of the order of 20-fold for ^{226}Ra. Thus the present radiation protection guide of 0.1 μCi ^{226}Ra appears to be very conservative even when applied to large populations. Realistic radiation protection guides for ^{90}Sr, ^{239}Pu, and other radionuclides for which there are no quantified cases of human injury may be estimated by combining these measured responses of humans to ^{226}Ra and ^{228}Ra with animal experiments now being conducted elsewhere on the ratio of the toxicity of ^{90}Sr, ^{239}Pu, etc. to that of ^{226}Ra. It is of special importance to extend the quantitative studies on as large a human population as possible for the entire life span especially of those individuals whose residual skeletal burden is in or near the range of 0.05 to 0.50 μCi ^{226}Ra or its ^{228}Ra dosimetric equivalent. (auth)

8995 THRESHOLD HYPOXIA: ITS EFFECT ON THE SURVIVAL OF MAMMALIAN CELLS IRRADIATED AT HIGH AND LOW DOSE-RATES. Bedford, Joel S.; Hall, Eric J. (Churchill Hospital, Oxford). Brit. J. Radiol., 39: 896-900(Dec. 1966).

HeLa cells cultured in vitro were exposed to ^{60}Co γ rays delivered as acute exposures (103 rads/minute) or protracted exposures (30 rads/hour). The radiation was given under conditions

of normal aeration and under threshold hypoxia, defined to be the presence of about 340 parts per million of oxygen in the gas phase. The survival curves for acute exposures under normal aeration and under threshold hypoxia both had extrapolation numbers (N) of 1.5, and had 37 per cent dose-slopes (D_0) of 180 and 435 rads respectively; the oxygen enhancement ratio is thus about 2.4. For protracted exposures, the survival curve under aerated conditions exhibited an N of 1.0 and D_0 of 260 rads; under threshold hypoxia the N was 1.5 and the D_0 was 405 rads. At this low dose-rate, oxygen did not appear to be a simple dose-modifying agent; the oxygen enhancement ratio calculated from the ratio of the limiting slopes was about 1.56. (auth)

8996 EFFECTS OF X IRRADIATION ON MALE HUMAN FERTILITY. Sandeman, T. F. (Peter MacCallum Clinic, Melbourne). Brit. J. Radiol., 39: 901-7(Dec. 1966).

After abdominal irradiation for testicular tumor, 18 of 273 patients reported 22 successful pregnancies. Their progeny are clinically normal. Sperm counts were obtained from eight of these, but did not appear to correlate at all with their proven fertility. Thirty-six other patients had either serial or solitary sperm counts and a pattern of response was detectable, although individual responses varied. (auth)

8997 ASSESSMENT OF BLOOD INDICES SHIFTS IN CHRONIC OCCUPATIONAL IRRADIATION OF ROENTGENOLOGISTS. Goldberg, E. D. Med. Radiol., 11: No. 8, 53-5(Aug. 1966). (In Russian).

The author investigated 250 workers of x ray rooms and compared the results with data derived from 400 healthy persons. During the chronic effect of low doses of ionizing radiation the following blood indices changes develop: a drop in the content of erythrocytes, thrombocytes, leukocytes, absolute lymphocytosis and neutropenia, monocytopenia, eosinopenia. A tendency towards the development of macrocytosis is noted. (auth)

8998 CHANGES IN TOXICITY OF CERTAIN ANESTHETIC DRUGS USED IN EXPERIMENTS ON MICE WITH ACUTE RADIATION ILLNESS. Pokorny, J. (Central Military Hospital, Prague) Pospisil, J. Voj. Zdravot. Listy, No. 2, 50-5(1966). (In Czech.).

The need to know the toxicity of certain anesthetics to persons suffering from radiation sickness led to the present study of 14 anesthetic drugs. The following drugs — mostly Czechoslovakian products — were tested: thiopental, syntostigmin, succinylcholinjodid, procuran, tubocurarin, remyolan, syntophyllin, calcium chloratum, largactil, dolsin, procain, mesocain, hexamethonium and thiameton. Laboratory mice were irradiated using the Makrophos 250 apparatus. A total of 410 animals were tested; the drugs were injected intravenously in 5 doses, each drug to 10 irradiated animals and to 10 control animals. The test results are shown in a table and in graphs. From the data, tentative conclusions may be shown concerning use of these anesthetics during acute radiation sickness. However, final judgment should be reserved until the methods of administering clinical anesthesia to irradiated animals have been verified. Major changes in relative toxicity were found with chloropromazin (largactil) and mezocain. The authors consider the administration of these drugs to irradiated organisms to be unsuitable, while thiopental is considered safe, even in cases of acute radiation illness. (auth)

8999 RADIOAUTOGRAPHIC STUDY OF HEMOPOIETIC REPOPULATION USING IRRADIATED PARABIOTIC RATS: RELATION TO THE STEM CELL PROBLEM. Tyler, Ruth W. Caffrey; Everett, N. B. (Univ. of Washington, Seattle). Blood, 28: 873-90(Dec. 1966).

Radioautographic studies using parabiotic rats and partial marrow shielding showed that cells responsible for recovery of γ irradiated bone marrow had their origin in the shielded marrow. Three morphologically distinct cell types appeared in the blood of these parabionts, mature granulocytes, small lymphocytes, and monocytoid cells. The monocytoid was the major cell type which crossed from the shielded to nonshielded marrow, and the observations suggested that it is this cell which served as a stem cell for both the erythrocytic and granulocytic cell lines. Erythroblasts and myeloblasts labeled with ^{3}H-thymidine were observed in the recovering marrow and the labeling intensity of these cells indicated that they were the second or third division products of labeled immigrant cells. The effect of marrow shielding upon the recovery of lymphopoiesis in spleen, thymus, lymph nodes, and bone marrow is also discussed. (55 references.) (auth)

9000 ALLOGENEIC MARROW ENGRAFTMENT BY CROSS CIRCULATION IN LETHALLY IRRADIATED DOGS. Epstein, R. B.; Graham, T. C.; Buckner, C. D.; Bryant, J.; Thomas, E. D. (Univ. of Washington, Seattle. Public Health Service Hospital, Seattle). Blood, 28: 692-707(Nov. 1966).

Dogs given 1200 R whole-body doses of ^{60}Co γ rays were cross-circulated with dogs having normal marrow function. Irradiated controls died in from 4 to 11 days with marrow aplasia. Dogs cross-circulated daily for 6 to 9 days showed histological evidence of bone marrow repopulation after 1 week. Male dogs cross-circulated with female partners showed typical female drumsticks on mature granulocytes after repopulation had occurred. Cytogenetic studies of an irradiated male dog cross-circulated with a female partner showed all mitotable cells from the bone marrow and peripheral blood to be of female donor type. Allogeneic bone marrow engraftment was associated with an early and severe secondary syndrome which resulted in the death of the animals in the second week. When methotrexate was given, survival was increased to 3 weeks. It was concluded that cross circulation provided leukocytes and platelets adequate for support during the period of radiation-induced marrow aplasia; allogeneic marrow engraftment was produced consistently by cells transferred in the peripheral blood of the normal cross circulation partner; the grafts were associated with an early and severe form of secondary disease; and methotrexate given during the early period of engraftment reduced the severity of the secondary disease. (auth)

9001 PATHOLOGY OF THE EFFECT OF THE LASER BEAM ON THE SKIN. Goldman, Leon; Blaney, Donald J.; Kindel, Dan J. Jr.; Richfield, Daniel; Franke, Ernst K. (Univ. of Cincinnati). Nature, 197: 912-14(Mar. 2, 1963).

Effect of a ruby laser beam (6943 Å) on the following skin specimens was studied histologically: white skin of rabbits and man, colored skin of animals and man, pigmented basosquamous papillomas (so-called seborrheic keratoses), superficial hematomas in the skin of man, white skin of man covered with lamp black, indian ink, tars, and colored by dihydroxyacetone. In addition, the following biological materials were exposed to the laser beam: black widow spider, cockroaches, caterpillars, fresh human cytological preparations from buccal and vaginal mucosa, pigmented and nonpigmented basal cell carcinomas, melanomas, basosquamous acanthomas, molluscum contagiosum, wart, tissue cultures of HeLa cells, cultures of human chromosomes, cultures of bacteria and fungi. The lesions in man were superficial even in heavily pigmented skin, but the deeper the pigmentation, the deeper the involvement of the epidermis. This is due to the absorption of energy of the laser beams in black substances. On white skin no pathology could be observed. In colored skin, the laser produced superficial lesions with fragmentation and splitting of the stratum corneum. Sulfhydryl stains showed no changes of keratin adjacent to the impact area. In more severe lesions of colored skin, cells of the upper spinous layer were eosinophilic and pycnotic; basal cells showed hydropic degeneration with cellular contraction, eosinophilia and pyknosis. Edema was found in epithelial cells adjacent to the impact area. The dermis also showed edema and perivascular infiltrate. In some areas the perivascular infiltrate included eosinophils which had migrated also into the epidermis 4 hr after exposure. On skin and hair of albino rabbits no lesions were evident. In the black pigmented skin of rabbit ear tissue destruction was produced. (BBB)

9002 ELECTROPHORESIS STUDY OF IRRADIATED LYMPHOCYTES. Spangler, George Wesley. Los Angeles, Univ. of California, 1966. 111p.

Thesis.

The mobility of rabbit blood lymphocytes was studied by use of a special liquid curtain electrophoretic cell separator. A 200 R exposure to ionizing radiation changes the distributions of electrophoretic mobilities in these cells. Cell volume distribution studies, using an electronic counting and sizing apparatus, show that a similar exposure to ionizing radiation produces transient changes in the relative fractions of small, medium and large blood lymphocytes during the first two weeks following exposure. An attempt is made to correlate these studies, which include some observations on normal and irradiated lymphocytes utilizing the electron microscope, with reported studies on the changes induced by antigenic stimulation. The specific results obtained in these experiments are: A suspension of rabbit red cells and lymphocytes can be electrophoretically separated in an ionically osmotically balanced physiological medium, without impairing subsequent viability and growth. Using the optimum separating settings approximately 30 percent of the total lymphocytes are found in the high mobility fraction. The in vitro exposure of rabbit blood to 200 R of gamma radiation produces approximately a 25 percent increase of the most electrophoretically mobile fraction in blood lymphocytes two to four hours after irradiation. A 400 R exposure under similar conditions produces approximately a fifty percent increase in the most mobile fraction. The in vivo exposure of rabbits to 200 R of gamma radiation produces a 130 percent increase of the most electrophoretically mobile fraction in blood lymphocytes from peripheral blood samples taken five minutes after irradiation. The radiation induced electrophoretic mobility effect was not observed when the measurements were carried out at 3°C to 8°C. In vivo exposure of rab-

bits to 200 R of ionizing radiation produces changes in the cell volume distributions of blood lymphocytes, which vary with time after irradiation. At two days after exposure there is a 22 percent increase in the fraction of small lymphocytes (i.e., 7μ to 9μ dia.), at seven and nine days there is a 14 percent increase in the fraction of medium lymphocytes (i.e., 9μ to 10μ dia.) and at fifteen days there is a 55 percent increase in the fraction of large lymphocytes (i.e., 10μ to 14.6μ dia.). In vivo exposure of rabbits to 200 R of ionizing radiation produces changes in the morphology of blood lymphocytes. The most significant change observed was a highly developed endoplasmic reticulum shown with the electron micrographs in samples taken eight days after irradiation. (Dissertation Abstr.)

9003 SOMATIC CELL MATING IN RADIATION-BONE MARROW CHIMERAS. Shaw, Don H. (Tuskegee Inst., Ala.). 4p. (CONF-660446-1). ORAU. Gmelin, AED-CONF-66-234-1.

From Discussion Meeting on Bone Marrow Transplantation and Chemical Radiation Protection, Atlantic City.

A review of published data on red blood cell types in chimeric pigeons is presented. Long-term chimeric survivors appeared to have a third erythrocyte type in addition to the host and donor types. The third type was agglutinated by both antisera. The hybrid cells appeared to contain the genetic constitution of both host and donor erythrocytes. It is thought that this group of erythrocytes could be the result of genetic transformation, DNA-transduction, or somatic cell mating similar to that described for the mating of mammalian tumor cells. (H.L.W.)

9004 RADIOBIOLOGICAL EVALUATION OF COMBINED STRESS. Musgrove, W. S.; Sprague, E. B. (Boeing Co., Seattle). 16p. (CONF-650560-16). ORAU.

From 13th Annual Meeting of the Radiation Research Society, Philadelphia.

Work has been performed using radiation, linear acceleration, and vibration as sources of stress. These sources of stress have been combined in various sequences including sequential exposures to one type of stress source only. The effects have been found to be very dependent not only on dose magnitude and dose rate, but also upon the time interval between exposures to sources of stress. Male Charles River CD rats were used in this study and kept in a relatively stress-free colony. Effects have been found to include no interaction, protection, or synergism, depending upon the variables of dose magnitude, dose rate, and time interval. Hypotheses and preliminary results tending to support the hypotheses will be presented. (auth)

Radiation Effects on Plants

Refer also to abstracts 8476, 8749, 8769, 8774, 8775, and 8929.

9005 (AD-629139) POSTATTACK FARM PROBLEMS. PART II. ATTACK EFFECTS ON INPUTS AND FARM OUTPUT. Williamson, Oliver E.; Moll, Kendall D. (Stanford Research Inst., Menlo Park, Calif.). Oct. 1961. Contracts CDM-SR-59-19; CDM-SR-60-37. 196p. CFSTI $19.20 cy, $1.25 mn.

Farm food production in the first year after a nuclear attack might be less than demands of the surviving population unless several major adaptations are made. With mobilization measures such as conversion of croplands from non-food and livestock feed production to human food production and use of surplus commodity stocks for livestock feed, adequate production could probably be maintained. Food production would increase in subsequent years unless national recovery were prevented by continued unsettled conditions. Contamination of cropland and losses of livestock would probably be the most serious constraints to agricultural production for the first postattack year. However, if fallout effects on cropland and livestock were less serious than currently estimated, casualties among farmers could be the chief constraint. In any event, production would probably be limited primarily by one of these constraints, rather than by the cumulative effects of less critical inputs. Estimates of production for a range of assumptions about human, animal, and crop vulnerabilities to attack are given. (STAR)

9006 (EUR-3163.e) APPLICATION OF ATOMIC ENERGY IN AGRICULTURE. Annual Report, 1965. (Instituut voor Toepassing van Atoomenergie in de Landbouw, Wageningen (Netherlands)). Oct. 1966. 66p. Dep. mn.

The research activities of the EURATOM-ITAL Association were directed in 1965 to the application of atomic energy to agriculture. In addition to classical plant breeding experiments using x radiation as mutagen, studies were undertaken to investigate the improvement of mutagenic efficiency and the analysis of irradiation effects, as well as to assess the possibilities offered by electron irradiation for the preservation of fruits and vegetables. Related physical problems were also investigated. The behavior of ^{45}Ca, ^{36}Cl, ^{134}Cs, ^{42}K, ^{32}P, ^{86}Rb, ^{35}S, ^{85}Sr, ^{90}Sr, and ^{65}Zn in plants and soils as well as the development and improvement of nuclear techniques for agricultural research also formed part of the activities of the Association. A list is included of 49 publications that report the research results in detail. (auth)

9007 (ORNL-3999, 160-5) PLANT PHYSIOLOGY AND PHOTOSYNTHESIS. (Oak Ridge National Lab., Tenn.).

Progress is reported on the following studies: characterization and modification of the radiation-induced, seed-hydration-resistant ESR signal in lettuce; separate and opposite actions of gamma irradiation on in vivo chlorophyll destruction in light and in darkness; prevention of radiation-induced root meristem collapse by radiation-induced mitotic inhibition; histologic aspects of nuclear labeling of Vicia faba roots exposed to H-thymidine for short times; nucleic acid synthesis in interphase nuclei of Vicia faba; photosynthesis. (H.L.W.)

9008 AGROFON AND THE EFFECT OF EXPOSURE OF SEED BEANS TO IONIZING RADIATION. Shutov, A. A. (Agrofizicheskii Institut, USSR). Vestn. Sel'shokhoz. Nauki (Moscow). 7: 130-1(July 1965). (In Russian).

Russian black beans were air dried and irradiated with 500 to 10,000 R gamma radiation. After irradiation the beans were planted in either a medium sandy soil fertilized with 20 tons manure per hectare or in a podzolic clay loam soil. During the vegetative season, the sandy soil was fertilized with a 15-20-15 mixture of Agrofon, while the loam soil was not fertilized. Data are presented for the effects of the radiation doses used on number of stalks per plant, length of main stem, length of first lateral stem, wet weights and dry weights of green material, number of beans per plant, number of beans per main stalk, and weights of beans per plant. Data were taken from plants grown in fertilized, unfertilized, and control soils. (TSS)

9009 SYSTEM FOR MEASURING PENETRATION OF RADIOACTIVE IONS ACROSS ROOTS OF INTACT PLANTS. Emmert, Fred H. (Univ. of Connecticut, Storrs). Contract AT(30-1)-2117. Plant Physiol., 41: 244-7(Feb. 1966).

An improved technique was developed for estimating penetration of ^{32}P across roots of intact plants (Phaseolus vulgaris) by measuring the level of isotope in the xylem stream. Penetration was defined as movement from the root surface to the xylem sap. The xylem sap measurement for ^{32}P was made in the stem as the material ascended the plant in the transpiration stream. Stems were held near 0° to arrest metabolic concentration of isotope adjacent to the xylem column. A 3-layer environment control system was constructed to allow stem chilling in a manner that would not interfere with the environments of the roots or foliage. Despite these precautions, some extra xylary build-up of ^{32}P occurred in the chilled stem. The mathematical function of the extraxylary fraction was derived, and the difference between this value and total ^{32}P in the stem represented xylem sap isotope. (BBB)

9010 ATOMIC RESEARCH SERVES DANISH FARMING. Joergensen, J. Helms (Atomic Energy Commission, Riso, Denmark). Danish Foreign Office J., No. 52, 39-41(May 1965).

Research projects of the Denmark Department of Agriculture, Atomic Energy Commission, at Riso, Denmark, are outlined. Project studies encompassed research on fallout isotopes in soil and their uptake in plants; applied and theoretical research on the use of ionizing radiations for preservation and sprout inhibition of fresh fruit, vegetables, and potatoes; and plant breeding research that includes breeding methods and techniques in the utilization of ionizing radiations and mutagenic chemicals for inducing mutations in cultivated plants. Emphasis has been placed on obtaining cereal varieties that are resistant to root rot from pathogenic fungi. The aims of the program are to acquire knowledge of the pathogenic fungi and to develop resistant varieties of wheat and barley by using radiation. The two most serious root-rot fungi of resistant winter wheat being studied are Cercosporella herpotrichoides and Ophiobolus graminis. Research is also being conducted on breeding methods for mildew resistance in barley; ~1,500,000 seedlings of irradiated barley are being tested at Riso for resistance to mildew fungus. (TSS)

9011 EFFECTS OF CALCIUM AND IRRADIATION ON POLLEN TUBE GROWTH. Espiritu, Lucila G. (Univ. of Hawaii, Honolulu). Philippine Agriculturist, 48: 49-60(July-Aug. 1964).

A study was conducted to determine the effects of calcium on pollen germination of different plant species, to test the calcium absorption by irradiated pollen tubes using ^{45}Ca in autoradiography, and to test the effects of various concentrations of calcium on radiosensitivity of pollen grains to x and uv radiation. The four species studied were Crotolaria juncea, Psidium guajava, Momordica balsamina, and Crinum asiaticum. Results indicated that germination and growth of pollen from all species tested were significantly increased by calcium ion added to the

basic sucrose medium. The optimum concentration of calcium ion was 300 ppM for all species. Growing pollen tubes of Crotolaria irradiated with 600 kR of 2 MeV x rays absorbed little or no ^{45}Ca. Incorporation of ^{45}Ca in the controls was marked, and was confined to the cell walls. Pretreatment of Crotolaria pollen with various calcium concentrations revealed no measurable protection against either x or uv radiations. Although germination and growth were lowered greatly by high calcium levels, the survival curves at the different concentrations were very similar. In practically all levels of calcium, fresh Crotolaria pollen were relatively resistant to x rays up to 400 kR. Pollen germination (2.4%) was recorded even at a relatively high uv dose (69×10^6 erg/cm^2). The survival curves with uv irradiation at all concentrations of calcium were essentially exponential, confirming the earlier suggestion of a one-hit target. Patterns of reduction in tube growth with increasing uv dose were similarly exponential. On the other hand, all the killing curves with x irradiation were sigmoidal, suggesting a multiple target. (BBB)

9012 OCCURRENCE OF MUTATIONS FROM X IRRADIATION AT DIFFERENT STAGES OF GERMINATION OF RICE SEEDS. Yamaguchi, H.; Miah, M. A. Jalil (Tokyo Univ.). Ikushugaku Zasshi, 15: 72(1965). (In Japanese).

Germinating seeds of the rice variety Kinmaze were x irradiated at doses of 5000 and 10,000 R. Germination was carried out for 24 to 96 hr at 25°. Number of maturing plants, seed fertility of X_1 panicle, and frequency of chlorophyll mutations in the X_2 generation decreased with germinating time. The segregation ratio of chlorophyll mutants within a mutated primary branch of X_1 panicle was about 0.25 in the 24- and 48-hr germinating seeds, but the ratio was significantly less than 0.25 in the 72- and 96-hr germinating seeds. It is suggested that the first mitosis of the seed embryo cell contributing to the formation of germinal tissue did not occur up to 48 hr after the initiation of seed soaking. Cytological observations of shoot meristem showed that there was no mitosis in the 48-hr germinating seed, but many dividing cells in 72-hr germinating seed. (BBB)

9013 PRELIMINARY INVESTIGATION OF THE INTERACTION OF IONIZING RADIATION AND COMPETITION ON THE GROWTH OF RADISHES. Cotter, David J. (Alabama Coll., Montevallo). Bull. Ga. Acad. Sci., 24: 38-43(Jan. 1966).

The relative effects of different levels of γ radiation, plant competition, and the interaction of these stresses on the growth of plant organs were studied using globe-type radishes as the experimental plants, since their underground storage organs serve as a general indicator of the overall condition of the plants. Scarlet globe radish seeds were exposed to 25,000 R and 50,000 R of ^{137}Cs γ radiation and planted at 5 cm or 10 cm intervals. After six weeks' growth the radishes were harvested, and fresh weight of root and shoot systems was measured. In both root and shoot weight the variation attributed to stand density had the larger mean square among treatments; hence, stand density produced the larger effect. The interaction between radiation and density was not significant and contributed less than 1% of the variation in growth of shoots and roots. Shoot weights after exposures of 25,000 and 50,000 R to seed were similar. Shoot growth from all nonirradiated seeds at both densities was significantly heavier than those receiving 25,000 R, and the difference was highly significant for those receiving 50,000 R. Root growth was more variable than shoot growth, indicating a greater growth response to the radiation and plant competition. The ratio of growth of controls to those exposed to radiation revealed a much greater disparity in the root than shoot growth, except in the 25,000-R, 10-cm group with the weight difference being more pronounced at the higher radiation treatment. Therefore, the results indicated a greater effect of radiation on root growth than shoot growth. Since the interaction between radiation and density did not approach significance, this experiment suggests independence of these factors. Radiation and plant competition apparently have different effects and consequently different results. (BBB)

9014 STUDY OF SPONTANEOUS RESTORATION IN ARTICHOKE TISSUES BY THE TECHNIQUE OF PARTIAL RADIATION. Jonard, Robert. Compt. Rend., Ser. D, 263: 937-9 (Oct. 3, 1966). (In French).

The technique of partial radiation of an organ followed by inoculation of isolated fragments into a medium containing auxin permits the study of spontaneous restoration in the irradiated tissues; this restoration is effected only in cases where the entire organ is left at rest between the irradiation and later inoculation of tissue. (tr-auth)

9015 IONIZING RADIATION EFFECTS ON THE PHOTOSYNTHESIS IN COTTON PLANTS OF VARIOUS RADIOSENSITIVITIES. Nazirov, N. N. (Inst. of Experimental Biology of Agriculture, Academy of Sciences, Uzbek SSR). Uzb. Biol. Zh., No. 3, 3-8(1966). (In Russian).

In the irradiation of cotton seedlings at γ doses of 10 kR the intensity of photosynthesis in radiosensitive varieties after irradiation noticeably decreases and in radiostable varieties increases. After 7 days the total photosynthesis is retarded in these varieties. Such a picture in radiosensitive varieties appears with weak doses of 0.5 to 2 kR. In the radioresistant varieties 1306-DV immediately after irradiation at high doses of 10 kR the formation of albumen increases and hexophosphate is retarded and in the radiosensitive varieties S-1622 it is reversed. The synthesis of fatty acids and starch increases in both varieties. The speed of formation of one assimulator is changed in the reverse direction, and the other leads to the norm. With comparatively low doses in the radioresistant variety (2 kR) the intensity of starch biosynthesis is irreversibly increased and in radiosensitive plants the albumen is increased after a dose of 0.5 kR. (tr-auth)

9016 EFFECTS OF LOW TEMPERATURES ON SEEDS DURING POST RADIATION STORAGE. Filev, K. (Central Lab. of Genetics, Academy of Agricultural Science, Sofia). Compt. Rend. Acad. Bulg. Sci., 19: 217-20(1966).

Barley seeds were irradiated with cobalt-60 and stored at 0 and 78°C. Prior to germination the seeds were soaked in water for one day at room temperature. The effect of low temperatures was to reduce the number of chromosome aberrations in irradiated seeds. An exponential relation between the percentage of chromosome aberrations and the length of storage time at low temperatures was observed. Mathematical analyses based on the least-square method showed a linear reduction in the percentage of aberrations at an increased dose for all post-radiation storage durations at low temperatures. With a high dose rate the effect of low temperatures in the post-radiation period was well defined but was insignificant at a low dose rate. Low temperatures stopped the indirect action of radiation and prevented potential injuries from becoming irreversible. (H.L.W.)

9017 REVERSED DEVELOPMENT ORDER OF CORYMBS IN IRRADIATED COLONIES OF LEMNA MINOR. Kasinov, V. B. (Ioffe Inst. of Physics and Tech., Leningrad). Dokl. Akad. Nauk SSSR, 167: 201-4(Mar. 1, 1966). (In Russian).

Daughter corymbs of Lemna minor appear preferentially e r at the left or at the right of the mother plant. It was assumed that the left- (L+) or right-sidedness (R+) is determined by accidental factors. Follow-up studies on Lemna perpusilla which indicated that exposure of R+ types to x radiation results in the appearance of L+ types, this inversion was further examined on Lemna minor specimens exposed to 1, 2, 6 and 12 kR of γ radiation from a ^{60}Co source. Irradiated and unirradiated colonies were further cultivated, transplanting them in separate containers and determining the extent of inversion. The results indicated that the ratio between the inverted, intermediate and reversive clones was 1:2:1. This ratio is very important for understanding the mechanism involved in the phenomenon of inversion; the similarity to Mendel's law of division according to genotype represents a superficial analogy. (TTT)

9018 STUDIES OF CHLOROPLAST DEVELOPMENT IN EUGLENA. XV. FACTORS INFLUENCING THE DECAY OF PHOTOREACTIVABILITY OF GREEN COLONY FORMATION. Hill, Helene Z.; Schiff, J. A.; Epstein, H. T. (Brandeis Univ., Waltham, Mass. Harvard Medical School, Boston). Biophys. J., 6: 373-83(July 1966).

When UV-treated cells of Euglena gracilis var. bacillaris are incubated in the dark in a nutrient medium which permits cell division, they lose the ability to be photoreactivated. The rate of this loss increases with the UV dose. For any given UV dose, the rate of decay increases with increasing growth rate. The same phenomena are observed in light-grown and in dark-grown cells, although the sensitivity to UV of the light-grown cells is smaller by a factor of 1.7. The kinetics of photoreactivation (PR) change during the decay of photoreactivability only if the cells are incubated in growth medium. A UV-inactivation curve for cells photoreactivated only after appreciable PR shows the same slope as that for untreated cells (number of UV-sensitive targets). These results are discussed from the point of view of possible models. (auth)

9019 EFFECTS OF ^{60}Co GAMMA IRRADIATION ON CORN POLLEN. Rodriguez, Vicente; Linden, D. B. (Puerto Rico Nuclear Center, Mayaguez). J. Agr. Univ. Puerto Rico, 50: 10-17 (Jan. 1966).

Corn tassels were irradiated using ^{60}Co γ rays at dose levels from 250 to 20,000 R. Twenty-four and forty-eight hours after irradiation the pollen was collected from the tassels and used to fertilize ears. The quantity of good seeds per ear, the germination percentage of these good seeds, and the seedling height 7 and 14 days later of the plants from these germinated seeds were recorded. No seeds were obtained beyond 4,000 R. There was little

effect from pollen used 24 hours after treatment compared with pollen used 48 hours after treatment for any of the characters measured. There was a general dose response for number of good seeds per ear, and also in the percentage of germination of those seeds classified as good. The higher doses reduced both numbers of good seeds and their germination. There was no evident dose response of seedling height. If the seed did germinate it grew about as well as any at the dose levels measured. (auth)

9020 THE USE OF INDUCED MUTATIONS IN PLANT BREEDING. Report of the FAO/IAEA Technical Meeting, Rome, 25 May–1st June 1964. New York, Pergamon Press, 1965. 839p. (CONF-551).

Sixty-six papers were presented on: the nature of mutations; effects of mutagens on plants; diplontic selection; characteristics and genetic analysis in induced mutants; and induced mutations and breeding methods in sexually- and vegetatively-propagated species. For the eight papers previously abstracted in NSA, see CONF-551 in the report number index. (H.G.D.)

9021 EFFECTS OF ^{32}P BETA RADIATION ON GROWTH, RESPIRATION AND CATALASE ACTIVITY IN THE SEEDLINGS OF PHASEOLUS VULGARIS L. Stan, Stelian (Central Inst. for Agricultural Research, Bucharest). Vienna, International Atomic Energy Agency, 1966, Preprint No. SM-77/2, 22p. (CONF-660912-5). ORAU.

From FAO/IAEA Symposium on the Use of Isotopes in Plant Nutrition and Physiology Studies, Vienna.

The growth, respiration, and catalase activity of kidney-bean seedlings in the initial phases of growth were studied after irradiation in ^{32}P solutions. A special technique was devised to permit uniform irradiation of individual seeds. The physical doses (corresponding to specific activities of 1, 10, and 100 μCi per seed) were 120 to 500 R, 1200 to 5000 R, and 12,000 to 50,000 R, respectively. All doses caused reduced seedling growth that was more pronounced towards the end of the period and different for the three doses. An exposure of 1 to 10 μCi per seed produced a slight stimulation of growth during the first 48 hrs, followed by inhibition until the end of the period. When the seeds received 100 μCi, inhibition of growth was observed after 24 hrs. The three treatments also produced different dry weight accumulations in the seedlings. Irradiation was found to exert considerable effects on respiration and catalase activity. Oxygen uptake in irradiated seedlings was noticeably higher than in unirradiated ones. Differences were found in this respect for the three doses used, but no correlation could be established between dose size and oxygen uptake. In every instance, the inhibition of respiration after the application of KCN was more marked in the case of the irradiated seedlings, indicating a difference in the respiratory capacity of the flavoprotein systems of irradiated and unirradiated seedlings. There was also a considerable rise in catalase activity after irradiation at all doses, but no relationship could be established between catalase activity and either dose or seedling age. The various mechanisms by which the enzymatic systems, physiological functions, and growth processes of the seedlings could be affected by irradiation are discussed. (H.G.D.)

Radiation Effects on Microorganisms

Refer also to abstracts 8476, 8762, and 8768.

9022 (COO-78-143) EFFECTS OF METABOLIC INHIBITORS AND RADIATIONS ON REGENERATION IN THE CILIATE STENTOR COERULEUS. Burchill, Brower Rene (Western Reserve Univ., Cleveland, Ohio. Dept. of Biology). May 1966. Contract W-31-109-eng-78. 140p. Dep. mn. CFSTI $4.00 cy, $1.00 mn.

Thesis.

Results are reported from an investigation of the nature of the nucleo-cytoplasmic interactions known to operate during regeneration of new feeding organelles in the ciliate protozoan Stentor coeruleus. The study included an analysis of the effects of uv and γ irradiation and the effects of inhibition of DNA and RNA synthesis, induced by metabolic inhibitors, during regeneration. These studies were performed in an attempt to alter the normal processes of regeneration in such a way that they might be better understood. In addition, the radiation studies were designed to permit an evaluation of the site in the cell which when damaged resulted in the observed radiation effects. (200 references.)(C.H.)

9023 (ORNL-3999, pp 127-31) CELL PHYSIOLOGY. (Oak Ridge National Lab., Tenn.).

Progress is reported on the following studies: freezing of bacteriophage T_4B; effect of cooling and warming velocity on the survival of frozen and thawed yeast; effect of freezing on the survival of Escherichia coli B/r-; sensitivity of frozen cells of Escherichia coli B/r to ultraviolet irradiation. (H.L.W.)

9024 CYBERNETIC INVESTIGATIONS ON RADIATION EFFECTS ON YEAST CELLS. II. INDUCTION OF LAG-TIME AND DEVELOPMENT OF GIANT CELLS AFTER X-IRRADIATION. Pohlit, W.; Domke, A. (Max-Planck-Institut fuer Biophysik, Frankfurt am Main). Biophysik, 3: 140-7(1966). (In German).

After x irradiation of Saccharomyces two different types of yeast cells were observed. The so-called n-cells, which cannot grow to macrocolonies, are produced by a typical reaction. Their further fate (giant cells) is independent of the applied absorbed dose. The other kind of cells, the so-called m-cells, can grow to macrocolonies. After x irradiation they show an induced lagtime and the curvature of the proliferation curve during the lagtime is a measure for the spread of the population of m-cells. Diploid and haploid yeast cells show the same general behavior. Nevertheless the sensitivity for the induced lagtime is within a factor of about two higher in haploid cells. This indicates differences between those strains due to reactions which can be regulated by the cell after irradiation. (auth)

9025 COPULATION OF ULTRA-VIOLET-IRRADIATED AND UNIRRADIATED SACCHAROMYCES CELLS OF DIFFERENT PLOIDY. Haefner, Klaus; Kirschfeld, Heinke (Freie Univ., Berlin). Nature, 211: 310-11(July 16, 1966).

Ultraviolet-irradiated diploid or tetraploid strains of Saccharomyces were mated with an unirradiated haploid strain. The frequency of lethal zygotes increased with uv dose in both diploid and tetraploid strains. Observations made with a phase-contrast microscope indicated the possibility that dominant uv damage is expressed only in zygotes with fused nuclei and that without fusion the unirradiated partner has a chance for survival. Hence, radioinduced lethality in Saccharomyces probably results from nuclear or mitotic damage. (H.G.D.)

9026 SURVIVAL OF MICROORGANISMS IN SPACE. Hotchin, John; Lorenz, Peter; Hemenway, Curtis (New York State Dept. of Health, Albany). Nature, 206: 442-5(May 1, 1965).

This report describes the first successful direct exposure of unprotected terrestrial microorganisms to the environment of space. Effects of radiation and other factors were studied in rocket and balloon flights, and effects of uv and soft x rays on the same microorganisms were examined in laboratory experiments. Bacillus subtilis spores, Chlorella pyrenoidosa cells, poliovirus type III (wild), and Escherichia coli bacteriophage T_1 samples were exposed. The microbiological results of the rocket flight showed no significant difference between shielded and exposed portions of either virus. The shielded sample of T_1 phage of the flight unit showed a viability not significantly different from the controls, whereas the unshielded viable count had fallen by a factor of 10^4. Viability of the balloon-flown shielded samples was not significantly different from the laboratory controls. Experiments were performed in the laboratory in an attempt to throw light on the nature of the primary cause of T_1 phage inactivation. (TSS)

9027 MULTIPLICATION OF LAMBDA PHAGE IN BACTERIA DEVOID OF ENZYMATIC ACTIVITY FOR REPAIR OF LESIONS INDUCED BY ULTRAVIOLET. Devoret, R.; Coquerelle, T. (Centre National de la Recherche Scientifique, Gif-sur-Yvette, France). Bull. Soc. Chim. Biol., 47: 1726-8(1965). (In French).

The effect of uv radiation on the multiplication of lambda phage was studied in Escherichia coli deprived of enzyme necessary for repair of radioinduced lesions in DNA. In lysogenic hcr$^-$ bacteria the release of induction and of the capacity to produce prophage is much more sensitive to the action of uv radiation than lysogenic bacteria of the wild strain. With strong uv doses, the infectious centers induced are inactive in proportion to the radiosensitivity of their products from infection by the indicator strain of the same genotype hcr$^-$. These results show that the degree of inactivation of the infectious centers induced corresponds to that attained by the prophage alone. Furthermore, they suggest that the capacity of the bacteria to reproduce phage is little affected by irradiation. This was confirmed by studies on the effect of irradiation on nonlysogenic bacteria irradiated after infection with intact phage. The results demonstrate that the functions of transcription and transfer of the DNA information of the phage necessary for its multiplication are relatively unaffected by irradiation of the host bacteria. (BBB)

9028 REPAIR OF ULTRAVIOLET LESIONS AND INDUCTION OF PROPHAGE. Kneser, H. (Univ., Cologne). Virology, 28: 701-6(Apr. 1966).

By measurement of dose-induction function for several λ-lysogenic strains of Escherichia coli with different reactivation mechanisms, it was found that dark-reactivation (DR) reactivates inducing lesions but K reactivation does not. For DR-positive strains the fraction induced is proportional to the uv dose under conditions of complete DR, while for DR-negative strains the fraction induced

is proportional to about the fourth power of the uv dose. It is concluded that several dark-reactivable lesions cooperate in λ induction, while a single nonreactivable lesion can probably induce the prophage. Therefore, the pathway to induction from reactivable uv lesions appears to be different from the pathway to induction from nonreactivable ones. Low uv doses kill Bs-1(λ) and BB(λ) cells without inducing the prophage, but higher doses induce these dead cells. It is concluded that killing and induction by uv are independent processes. The formal target size for induction is much smaller than that for killing. (BBB)

9029 STUDIES OF NUCLEAR STRUCTURE IN IRRADIATED SPOROGENOUS BACTERIA (DATA OBTAINED BY LUMINESCENCE MICROSCOPY). Safiyazov, Zh.; Medvedeva, G. A. (Div. of Microbiology, Academy of Sciences, Uzbek SSR). Uzb. Biol. Zh., No. 3, 20-3(1966). (In Russian).

The forms of sporogenous bacteria and their asporogenic mutants investigated have a morphologically developed nuclear structure. This component shows its constant functional structure. During retardation of cellular fission, appearing after irradiation, the division of the nuclear component is delayed as a result of which its dimensions are increased, corresponding to the increase of the growing and non-dividing cells. The investigation can be rapid by luminescent methods and these methods clearly show its distribution in bacterial cells and supplement the results obtained by means of electron microscopy. Artifacts originating occasionally during fixation of preparation for electron microscopy were eliminated. (tr-auth)

9030 DEVELOPMENT OF LACTOBACILLUS LACTIS IN IRRADIATED MILK. Dupuy, P. (Institut National de la Recherche Agronomique, Versailles, France); Mocquot, G. pp 165-72 of Applications des Rayonnements en France. Vol. I. Gif-sur-Yvette, France, Centre d'Etudes Nucleaires de Saclay, 1966. (In French).

Irradiation of milk with doses of up to 200 krad promotes the growth of Lactobacillus lactis, as estimated by reduction in pH and increase of titratable acidity, whereas higher doses have an inhibitory effect. In the latter case a decreased maximum number of bacteria was also observed. Using irradiated milk or whey, it was shown that the reduction in growth is due to inhibitory substances formed during and after irradiation, rather than to a deficiency in growth factors. Further experiments in which irradiated lactose and casein solutions were added to nonirradiated milk showed that no inhibitory substances are present. Similarly, no difference was observed in the growth of L. lactis with varying fat content of irradiated milk. The possible use of microbiological techniques for investigation of biologically active substances, which may be produced in irradiated products, is discussed. (auth)

9031 EFFECT OF RADIOACTIVITY OF AIR IN SOIL ON NITRIFICATION PROCESSES IN THE SOIL. Ananyan, V. L.; Avetisyan, A. Sh. Soobshch. Lab. Agrokhim., Akad. Nauk Arm. SSR, No. 5, 19-24(1964). (In Russian).

The effects of radium-radon decay products on nitrifying bacteria were studied in the laboratory. Samples of carbonate soil and leached chernozem were placed in glass cylinders and these were kept in a thermostat at 24 to 30°. The samples were kept moist. Nitrate ion content was determined in the aqueous extract by colorimetric methods. Radon increased nitrate ions in carbonate soil and reduced nitrate ions in chernozem. In the experiment on soil plus organic substance, the effect of radon on nitrifying bacteria was negative. (H.L.W.)

9032 EFFECT OF LARGE DOSES OF ^{60}Co γ RADIATION ON THE GAMETES OF LAMINARIA ANGUSTATA. Lu, Ch'eng-ch'ing; Hu, Tseng-sen; Ch'en, Chu-ch'i; Li, Yung-ch'i; Fang, Tsung-hsi. pp 94 of Chung Kuo Hai Yang Hu Chao Hsueh Hui 1963 Nien Hsueh Shu Nien Hui Lun Wen Chai Yao Hui Pien. Peking, 1964. (In Chinese).

Specimens of the seaweed, Laminaria angustata, were obtained from the cultivation field of Shantung College of Oceanography, and the gametes were cultured in sea water to which nutrients had been added. The culture was exposed to 1,000 metercandles of light for 9 to 10 hours each day. The gametes were exposed continuously to 125 R of gamma radiation from a cobalt-60 source. The total dosages were 40,000, 80,000 and 120,000 R. Microscopic examinations were made periodically. With a dose of 120,000 R death of some gametes occurred the day after radiation exposure. Female gametes were more resistant than male. A dose of 120,000 R caused death of all male gametes within 12 days, while only 60% of female gametes were killed in the same length of time. (H.L.W.)

9033 THE INFLUENCE OF TEMPERATURE ON THE CONTENT OF CYTOPLASMIC RIBONUCLEIC ACID IN PARAMECIUM CAUDATUM IRRADIATED WITH X-RAYS. Kovaleva, N. E. (Inst. of Cytology, Leningrad). Tsitologiya, 6: 709-17(1964). (In Russian).

Paramecium caudatum cultivated at different temperatures were irradiated with 75 kR of x rays and the content of cytoplasmic RNA was recorded to study the influence of adaptation to the temperature factor on the radiobiological reaction of the infusoria. The content of cytoplasmic RNA in the infusoria cultivated before and after irradiation at 22°C ("room temperature") was found to change during 30 days after the irradiation. The phases of the decrease and increase of the RNA amount alternated several times during a month. The RNA content in the infusoria cultivated before the irradiation at +4°C and after the irradiation at +22°C decreased greatly during the first week. Then it gradually increased and by the end of the month the level of the RNA content became high. The unirradiated infusoria revealed the same changes in the RNA content, but the phase of its decrease was less pronounced than that in the irradiated infusoria. The data obtained have shown that the adaptation of irradiated infusoria to the changed temperature regime influences greatly the character of the alterations in the content of the cytoplasmic RNA. (TSS)

9034 NATURE OF IRREVERSIBLE COMPONENT ACCOMPANYING γ-RAY DAMAGE OF YEAST. Barsukov, V. S.; Malinovskii, O. V.; Mityushova, N. M. (Pavlov Inst. of Physiology, Academy of Sciences, USSR). Dokl. Akad. Nauk SSSR, 167: 1162-3(Apr. 11, 1966). (In Russian).

An aqueous suspension of tetraploid yeast cells, Saccharomyces cerevisiae, were irradiated with ^{60}Co gamma rays, and then were irradiated with the same dose of 60,000 rads at 8 and 24 hr after the first irradiation. The survival at 24 hr after the first irradiation was 68%. Thus the fraction of irreversibly damaged cells was 32%. The survival after two irradiations was calculated as 46% which agrees well with an experimental value of 47%. The effects were additive with a time of 24 hr between the first and second irradiations. Dominant lethals due to chromosome breaks and rearrangements are thought to be the prime cause of cell death and irreversible damage. (TTT)

Radiosterilization and Radiopreservation

Refer also to abstracts 8752 and 9006.

9035 (CONF-661017–) SIXTH ANNUAL AEC FOOD IRRADIATION CONTRACTORS MEETING, WASHINGTON, D. C., OCTOBER 3–4, 1966. (Division of Isotopes Development (AEC), Washington, D. C.). 216p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Papers were presented on the current status of research on the following types of projects: application of radiation pasteurization to fishery products; effects of gamma radiation on haddock and clams inoculated with Clostridium botulinum; effects of radiation on microbial flora surviving radiation pasteurization of seafoods; irradiation of fruits and vegetables; radiation preservation of tropical foodstuffs; irradiation of grain and grain products; extraction studies of packaging materials to be used with irradiated foods and preparation of petitions on irradiated foods; effects of γ radiation and chemical treatment on quality of potatoes for fresh market and processing usage; operation, demonstration, and commercial prospects for Hawaii Development Irradiator; operation of the portable cesium irradiator; wholesomeness evaluation of radiation substerilized food products; animal feeding studies on radiation pasteurized foods; growth characteristics of Type E Clostridium botulinum; microbiological aspects of radiopasteurized chicken; mutagenesis of enteroviruses by gamma rays; radiation and physiology of fruit deterioration; stability of food lipids to ionizing radiation; basic research in the chemistry of fish; radiation of heme proteins. Summaries of the following subcommittees were presented: fruit and vegetable technology; marine and fish technology; microbiology; and wholesomeness. The following addresses to the general sessions were given: the unit cost of food irradiation; FDA regulations for irradiated foods and packaging materials; the importance of industrial participation in the national food irradiation program. (H.L.W.)

9036 (NYO–3274-4) SOME RADIATION-INDUCED CHANGES IN FRESH FRUITS AND VEGETABLES. Massey, Louis M. Jr.; Bourke, J. B. (New York State Agricultural Experiment Station, Geneva. Dept. of Food Science and Technology). [1965]. Contract AT(30-1)-3274. 15p. (CONF-650902–37). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

From American Chemical Society, 150th National Meeting, Atlantic City.

The overall effects of ionizing radiation upon fresh fruits and vegetables are many fold, including not only the immediate and direct influence upon chemical constitution, but also the subsequent indirect consequence of physiological and biochemical alteration. The most obvious detrimental response of fresh commodities to irradiation is softening. This is associated with the radiation-

induced degradation of both pectin and cellulose. Radiation-induced changes in physiology and biochemistry associated with storage longevity have also been studied. It was shown that the incidence of some disorders of physiological origin, such as storage scald in apples, may be reduced by radiation treatment. Ethylene synthesis is also altered by radiation. Kilorad treatment of most fruit and vegetable tissue results in during-irradiation stimulation of overall respiratory activity followed by return to near-normal rates. Investigations into the biochemical causes for this response are in progress. In carrots, there seems to be no significant alteration of either the pentose-phosphate or the Embden-Meyerhof systems of glucose metabolism. Although little effect of radiation upon the rate of pyruvate decarboxylation was found, there was a marked variation in acetate metabolism. (auth)

9037 SOME EFFECTS OF GAMMA RADIATION ON SEVERAL VARIETIES OF TASMANIAN POTATOES. I. STORAGE PROBLEMS. Wills, Pamela A. Austral. J. Exper. Agr. Animal Husbandry, 5: 282-8(1965).

The effects of doses of 5,000 and 10,000 rads of γ radiation and subsequent storage at 68°F and 45°F on sprouting of several varieties of potatoes were investigated. The majority of the irradiated tubers were commercially sound after 6 mo storage. Tubers stored at 45°F were in better condition than those stored at 68°F. (C.H.)

9038 CONTAMINATION OF MEAT SUPPLIES. PART I. SALMONELLA AND STAPHYLOCOCCUS. PART II. CLOSTRIDIUM WELCHII AND TOXOPLASMA. Hobbs, Betty C. (Central Public Health Lab., London). Mon. Bull. Min. Health, 24: 123-34; 145-51(May; June 1965).

Control of meat contamination by pathogenic organisms is discussed, and methods for reducing the chain of infection from farm to consumer are presented. Recommendations include: an amendment of the Slaughterhouse Regulations to limit the holding of pigs for a period of not longer than 2 days; the use of γ irradiation for animal feed known to be a source of salmonellas; and the use of γ irradiation for packs of imported frozen boneless meat that cannot be freed from salmonellas by improved hygiene during production. (TSS)

9039 TOXIC EFFECTS OF IRRADIATED FOODS. Loefroth, G. (Univ., Stockholm). Nature, 211: 302(July 16, 1966).

Hazards from radioinduced toxins in foods irradiated for the purpose of extending shelf life are considered. Since no evidence exists for the cellular specificity of activity for any class of compounds producing cytogenetic or cytotoxic changes, it is suggested that plant cells and cell cultures may be used in preliminary evaluation of irradiated foods. Such preliminary tests would be followed by tests in animals. (H.G.D.)

9040 EFFECTS OF IONIZING RADIATION ON POWDERED EGGS. Deschreider, A. R.; Meaux, R. (Ministry of Economic Affairs, Brussels). Ann. Fals. Expert. Chim., 58: 73-85(Jan.-Feb. 1965). (In French).

Results are reported from a study on the effects of γ radiation on the biochemical properties of powdered eggs. The egg powder was prepared from fresh eggs lyophilized to give a water content of 4%, packed in polyethylene bags under nitrogen, and irradiated with ^{60}Co to doses of 0.5, 1, and 2 Mrad. The irradiated egg powder was then examined by fractional extraction, column chromatography on carboxymethyl cellulose, paper electrophoresis, molecular filtration, spectrophotometry, and Kjeldahl analysis for nitrogen. The results of these analyses showed that irradiation caused the partial or total disappearance of carotenoids present in the acidified ether extract of lipids, diminution of proteins soluble in pH 4.0 buffer, and disappearance of characteristic protein fractions upon paper electrophoresis. The latter change was evident after the lowest radiation dose, 0.5 Mrad. None of the three changes was seen in non-irradiated egg powder stored for one year. (BBB)

9041 ^{60}Co IRRADIATION PLANT. Engineer, 214: 877-9 (Nov. 23, 1962).

A plant for sterilizing disposable plastic syringes with γ radiation from a ^{60}Co source is described and illustrated. The plant, designed specifically for sterilizing such medical appliances, was the first of its kind in the world. The objectives in design were to provide optimal conditions for irradiation of the packaged product, adequate shielding for the operating staff, and adequate protection for materials and equipment that would have been damaged by irradiation. General shielding was provided by concrete slabs (5 ft, 6 in. thick). Plant operation consisted of exposing cartons of syringes, loaded into special containers, to ^{60}Co. The cartons were transported via labyrinthine inlet and outlet openings into the concrete cell and then moved to and fro across the ^{60}Co source. The source consisted of cobalt rods (6 in. long, $\frac{1}{4}$ in. dia) that had been irradiated in a reactor to convert them to ^{60}Co. Each rod was encased in a stainless steel tube that was sealed at each end by an argon-arc welded cap. A cluster of 24 of these rods was placed and sealed in an outer sheath of stainless steel ($1\frac{5}{8}$ in. dia, 27 in. long). The initial source loading consisted of five tubes (120 rods) that were capable of producing 50,000 C and, if required, 500,000 C. Raising and lowering of the source from the safety pit was performed by a single-action hydraulic cylinder acting on a retaining cable. The working position of the source was determined by an oil pressure control system. In order to obtain an even dose, it was found necessary to pass all cartons across the bottom half of the source and then along the top half. In turn, both sides of the cartons were irradiated. A series of safety interlocks provided for correct sequence of operation; the primary function of the safety interlocks was to keep the cell closed when it contained the ^{60}Co source. (B.H.S.)

9042 CAN NUCLEAR ENERGY BE USED FOR THE PROTECTION OF CEREAL STORES AGAINST INSECTS? Pesson, P. Inform. Doc. Agr., No. 2, 1–12(Jan. 15, 1965). (In French).

Efforts to destroy the cattle fly in Florida using radiation sources are reviewed. The conditions under which sterilization of the male can be applicable to insect pests in cereal stores are defined. Hazards from the use of radiation are summarized. (J.S.R.)

9043 APPLICATIONS OF INTENSE RADIATION SOURCES TO FOODS AND BIOSYNTHETIC DRUGS. Mouton, Robert (Univ. Libre, Brussels). pp 173-207 of Applications des Rayonnements en France. Vol. I. Gif-sur-Yvette, France, Centre d'Etudes Nucleaires de Saclay, 1966. (In French).

The applications of high radiation sources to foods and biosynthetic drugs are considered. Justification of these applications of nuclear energy, their potentials, and their application limits were examined. The evolution of national and international research programs is outlined. Some fundamental concepts that can be used to guide present and future programs are given. (J.S.R.)

9044 INDUSTRIAL IRRADIATION: APPLICATION TO THE TREATMENT OF AGRICULTURAL AND FOOD PRODUCTS. Pierlas, R.; Rondenay, F. (Societe Saint-Gobain Nucleaire, Courbevoie, France). pp 5-17 of Applications des Rayonnements en France. Vol. I. Gif-sur-Yvette, France, Centre d'Etudes Nucleaires de Saclay, 1966. (In French).

The Cs irradiation facility at Saint-Gobain Nucleaire is described. The radiation facility is mobile and is designed to study exploitation costs and applications. The capital costs for an industrial irradiation facility are briefly considered. (J.S.R.)

9045 THERMO AND RADIOSENSITIVITY OF VITAMINS. Causeret, Jean; Mocquot, Germain (CNRS, Jouy-en-Josas, France). pp 149 64 of Applications des Rayonnements en France. Vol. I. Gif-sur-Yvette, France, Centre d'Etudes Nucleaires de Saclay, 1966. (In French).

From the monograph on the thermo- and radiosensitivity of vitamins, the section on conservation of food materials by ionizing radiation is presented. The technological and nutritional aspects of the radiation preservation of milk and milk products, meat, eggs, potatoes, fish, and cereals are considered. (J.S.R.)

9046 FOOD HYGIENE AND IONIZING RADIATIONS. Morre, J. (Laboratoire de Radiobiologie du Service Veterinaire de la Seine, Paris). pp 101-22 of Applications des Rayonnements en France. Vol. II. Gif-sur-Yvette, France, Centre d'Etudes Nucleaires de Saclay, 1966. (In French).

Nuclear energy affects food hygiene in two very different ways: active fallout contaminates the soil, plants, and animals but ionizing radiation can preserve food. Each of these two aspects are discussed. In the contamination of food the contamination is evaluated generally by a determination of either the total radioactivity or a determination of the concentration of ^{90}Sr and ^{137}Cs. The techniques used for food preservation are briefly outlined. The principle food elements exposed to ionizing radiation for preservation are reviewed. These include, fruits, potatoes, seafood, meats, and eggs. (J.S.R.)

9047 BIOSTIMULATIVE EFFECT OF IRRADIATED CHRYSALIS MEAL ON PIGLET DEVELOPMENT. Gavrila, V.; Jurubescu, V.; Alexe, Gh.; Holerca, J. Lucrari Stiint., Ser. C, VII, 451-4(1964). (In Rumanian).

Feed supplemented with an irradiated industrial meal including silk-worm pupae administered to piglets in progressive doses (starting with 0.50 cg/kg bodyweight) stimulated their growth and development rate. The supplement administered to a first lot resulted in a 6 kg gain, on the average, while the average daily gain in the second lot was of 60 to 70 g, as against the controls. The treatment was more efficient during winter than in summer. The 10-months observation period showed that the gilts of the first lot had 9 to 14-strong litters (as compared with the 6 to 9-strong litters of the controls) and that newly born piglets registered higher birth weights. (auth)

METALS, CERAMICS, AND OTHER MATERIALS

Metals and Alloys

9048 (BNWL–113-21) PLUTONIUM ABSTRACTS. VOLUME 6, NUMBER 9. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Oct. 31, 1966. Contract AT(45-1)-1830. 63p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Abstracts are presented that contain information on the biology and medicine, chemistry, health and safety, metallurgy and ceramics, physics, and reactor technology associated with plutonium. (J.R.D.)

9049 (GEMP–61, pp 93-104) OXIDATION-RESISTANT FUEL ELEMENT MATERIALS RESEARCH. Collins, J. F.; Stephan, H. R. (General Electric Co., Cincinnati, Ohio. Nuclear Materials and Propulsion Operation).

Details of development and evaluation of oxidation-resistant fuel elements for gas-cooled reactors are reported. Fundamental advances were made in the areas of fuel element stability, iron-base and chromium-base cladding alloys, and fission product retention under high burnup conditions. Nondestructive analytical procedures for quantitative measurement of surface U concentration were developed. (P.G.C.)

9050 (AD–643685) NEW MATERIALS IN ENGINEERING. Trostyanskaya, E. B.; Kolachev, B. A.; Silvestrovich, S. I. Translation of Novye Materialy v Tekhnike, Moscow, 1962. 944p. (FTD-HT–66-269). CFSTI $3.00 cy, $0.65 mn.

This book covers the new materials which are gaining acceptance in various engineering fields: synthetic polymers, silicate materials (glass, ceramics), metallic powders and cermets, metals and alloys (Ti and Zr alloys, Be, high-melting alloys), semiconductors and pure metals, and protective coatings. Specifications, properties, and methods and areas of their application are presented for each of the materials. (D.L.C.)

Corrosion and Erosion

Refer also to abstracts 8566, 9096, 9153, 9166, 9197, and 10216.

9051 (CEA-R–3028) CORROSION DU NIOBIUM PAR LE SODIUM LIQUIDE EN CIRCULATION ENTRE 400 ET 600 DEG C. (Niobium Corrosion in Flowing Liquid Sodium at 400 to 600 Deg C). Sannier, Jacques; Champeix, Louis; Darras, Raymond; Graff, Willy (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Oct. 1966. 30p. (In French). Dep. mn.

The corrosion of niobium and two of its alloys was studied under temperature, flow rate, and purity conditions of liquid sodium similar to those likely to occur in a fast neutron reactor. The results are discussed with reference to the following parameters: purification method used for the sodium, temperature, metallurgical condition of the structural metal. Generally speaking, an important role is played by the oxygen content of the liquid metal towards the corrosion of the niobium: although the metal behaves very satisfactorily when a hot trap purification is used, it undergoes corrosion in the presence of sodium which has been purified only by a cold trap. (tr-auth)

9052 (EURAEC–1744) STUDIES OF STEEL CORROSION IN HIGH TEMPERATURE WATER AND STEAM. Quarterly Report No. 16, July 1–September 30, 1966. (Societe d'Etudes, de Recherches et d'Applications pour l'Industrie, Brussels (Belgium)). Oct. 30, 1966. Contract 087-66-1-TEEB(RD). 89p. (EUR–3304). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Work Performed under United States–Euratom Joint Research and Development Program.

The study of the recrystallization conditions of various grades of milled stainless steels was continued. It was found that Uranus 30 steel offers good behavior under oxidation, after surface treatment, at temperatures at which standard 18-10 steels tend to deteriorate. The study of grain size, with or without prior selective oxidation treatment, was initiated on various grades of stainless steels. The initial results, for oxidation pretreatment at 800°C, indicate definite influence of the grain size under these conditions. The effect is quantitatively inadequate, however. Long-duration tests in superheated steam at 500°C on AISI 304 L steel show that the work-hardening depth obtained by grinding is insufficient to guarantee satisfactory steel behavior. Tests in superheated steam at 500°C with 20 ppM oxygen added do not show any weight differences from the tests carried out without oxygen. In the tests with oxygen added, the oxide skin formed on a surface work-hardened 304 steel remains of the spinel type whereas that formed on electrolytically polished steel consists primarily of α-Fe_2O_3. Experiments on chromized steels confirmed that chromization is an excellent method of reducing corrosion by superheated steam at high temperature. On the other hand, metallographic examination of original and oxidized specimens raises several questions concerning the structure and mechanical properties of the surface zone. An experiment carried out in CO_2 at 500°C on 304 steel shows surface treatment influence comparable to that observed in superheated steam at the same temperature. Isothermal tests on 410 steel in pressurized water at various temperatures confirmed that corrosion evaluation in pressurized water is highly influenced by the experimental conditions: geometry, nature of the walls, temperature gradients, specimens of different types or surface states, possible water renewal. All these factors influence the transport of corrosion products from ferrous hydroxide solubilization and magnetite precipitation from the solution. The influence of the pH on this process is seen from dynamic tests in water with lithia added. Addition of lithia reduces the steel corrosion in pressurized water which is renewed, and particularly reduces the "metal lost to the system" component of the corrosion. But the addition of 20 ppM oxygen raises the corrosion again to the level reached in pure water. For a zirconium–2 chromium–0.16 iron alloy in superheated steam at 450°C and 70 kg/cm^2, as in the case of Zircaloy-2, surface work-hardening seems unfavorable at the beginning of the experiment. The corrosion rates for the various surface states considered then level out. There is a very marked difference between the oxidation kinetics of zirconium–chromium and Zircaloy-2 in steam at 450°C: while the corrosion kinetics of Zircaloy-2 are practically linear after one week, those of zirconium–chromium have remained practically cubic for eight weeks. (D.L.C.)

9053 (EURAEC–1755) THE RELATIONSHIP OF NITROGEN CONTENT OF AUSTENITIC STAINLESS STEELS TO STRESS CORROSION. Quarterly Report No. 438-9, July 1–September 30, 1966. Cox, Thomas B. (Virginia Polytechnic Inst., Blacksburg. Dept. of Metals and Ceramic Engineering). Contract AT(40-1)-3208. 18p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Work Performed under United States–Euratom Joint Research and Development Program.

As part of an investigation to determine relationship between N content of austenitic stainless steels and susceptibility to stress-corrosion cracking, experiments were conducted in which the solubility of N_2 in AISI Types 304 and 308 stainless steel wires was determined. (P.G.C.)

9054 (LA–3602) TESTS FOR HYDROGEN EMBRITTLEMENT OF STEELS USED IN TANK FARM CYLINDERS. Mills, R. L.; Edeskuty, F. J. (Los Alamos Scientific Lab., N. Mex.). Oct. 1966. Contract W-7405-eng-36. 15p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Specimens of alloy steels used in H_2 storage tanks were exposed to gaseous H_2 under pressure for 24 hours. In separate tests, specimens were exposed to cathodic H_2 for 30 min at a current density of 1 A/in.^{2} Immediately following exposure, samples were deformed through successive 180° bends until broken. None of the steels was measurably affected by exposure to H_2 gas under the test conditions, but all steels were embrittled by cathodically liberated H_2. Cathodic embrittlement increased with time and stress of the samples. (P.G.C.)

9055 (ORNL-P–2655) LITHIUM AND POTASSIUM CORROSION STUDIES WITH REFRACTORY METALS. DeVan, J. H.; Litman, A. P.; DiStefano, J. R.; Sessions, C. E. (Oak Ridge National Lab., Tenn.). [1966]. Contract W-7405-eng-26. 25p. (CONF-661110–3). DTIE.

From IAEA Symposium on Alkali Metal Coolants, Corrosion Studies, and System Operating Experience, Vienna, Austria.

In the absence of O_2, alloys of Nb, Ta, or Mo showed little evidence of corrosion or mass transfer in boiling K for up to 10,000 hr at 1200°C and 5000 hr at 1300°C. Simulated nozzle and turbine blades made of Nb–1% Zr, TZM, and Mo–½% Ti showed little impingement damage upon exposure to high-velocity vapor for times up to 5000 hr at 1000 to 1200°C. Advanced refractory-metal alloys contain an active metal such as Hf or Zr which raises the minimum O_2 required for Li penetration by forming HfO_2 or ZrO_2, thus preventing O_2 from entering into corrosion reactions. Excellent compatibility of refractory metals with Li was demonstrated in thermal- and forced-circulation-loop tests operated for up to 10,000 hr at 1200°C. Results of transfer studies at 1200°C indicated a preferential transfer of Zr, N_2, and C in Nb-base systems. Further studies of this affect will be required at higher temperatures and flow rates. The generally good compatibility of refractory metals with both Li and K reported throughout the literature suggest that the use-

ful application of systems involving these materials may be limited by strength rather than corrosion. (auth)

9056 CORROSION BEHAVIOR OF REFRACTORY METALS IN LIQUID LITHIUM AND CESIUM VAPORS. DeMastry, J. A. (Battelle Memorial Inst., Columbus, Ohio). Met. Soc. Conf., 30: 521-33(1966).

Eight refractory metals and alloys were selected for corrosion studies in Li at 2500°F and Cs at 2500 to 3400°F. A number of specimens were exposed to Li at 2500°F and Cs at 2500, 2800, and 3100°F for 100 hr. Preliminary results indicate that W, W−25 Re, and TZM are compatible with Li at 2500°F and with Cs at 2500, 2800, and 3100°F. The results for the W−0.9 Nb alloy are inconclusive. The Ta−12W alloy shows a reaction zone with Li and Cs at the temperatures of interest. No observations were made on the W−15 Mo, B-66, and T111 alloys. (auth)

9057 Nb-BASE ALLOYS FOR USE IN A NUCLEAR SUPERHEATER. DeMastry, J. A.; Bauer, A. A.; Rough, F. A. (Battelle Memorial Inst., Columbus, Ohio). Met. Soc. Conf., 30: 561-73(1966).

Alloys containing additions of Cr, Mo, Ti, V, and Zr were prepared by arc melting. The corrosion resistance of these alloys was evaluated both in the cold worked (90 percent reduction) and annealed (1 hour at 2200°F) conditions by autoclave tests in 1500 psi steam at 1000°F. The results indicated that the additions of Mo and Zr are detrimental to corrosion resistance in the amounts studied. The additions of Cr, Ti, and V were beneficial. A striking improvement in corrosion resistance of material in the cold worked condition over that of annealed material was noted. A family of alloys containing additions of 18 to 24 at. % Ti, 12 to 18 at. % V, and 9 to 12 at.% Cr to Nb were developed which exhibit good corrosion resistance to 1000°F steam. Of these, an alloy of Nb−21 at. % Ti−12 at. % V−9 at. % Cr, exhibited outstanding corrosion resistance, having a 250 mg/dm^2 weight gain after 224 days exposure to 1000°F steam. (auth)

9058 METALLOGRAPHY OF REFRACTORY METALS SUBJECTED TO LIQUID METAL CORROSION. Sadofsky, J.; Kammerer, O. F.; Halford, J. (Brookhaven National Lab., Upton, N. Y.). Met. Soc. Conf., 30: 575-82(1966).

Corrosion studies in which refractory metals are used as container materials for Hg and Na at elevated temperatures, have produced several unique metallographic problems. The materials used in these experiments included Nb, Nb−1% Zr, and Nb−10% W−1% Zr. Each metal was fabricated into natural circulation boiling loops and operated for varying lengths of time with thermal differentials ranging from 390°C (315 to 705°C) in Hg to 555°C (760 to 1315°C) in Na. (auth)

9059 SCALE-UP OF PACK CEMENTATION COATINGS. Dioguardo, P. R.; Dormer, G. J.; Pike, E. G.; Payne, B. S. Jr. (Pfaudler Permutit, Inc., Rochester, N. Y.). Met. Soc. Conf., 30: 651-61(1966).

Precautions in scaling up pack cementation coatings from the laboratory to the production scale are described. The coating used is PFR-6, a reliable reproducible laboratory coating. The base metal used is TZM Mo alloy (Mo−0.5% Ti−0.07% Zr). Specific information is given for heat transfer, impact and bend characteristics, and space relations in the retort. (P.C.H.)

9060 ADVANCES IN COATING DEPOSITION TECHNIQUES FOR REFRACTORY METAL STRUCTURES. Aves, W. L. Jr.; Ecord, G. M. (Ling Temco Vought Co., Dallas, Tex.). Met. Soc. Conf., 30: 663-9(1966).

Advanced process modifications associated with vapor deposition techniques for coating applications on large or complex refractory metal structures are presented. (P.C.H.)

9061 ELECTROPHORETIC COATINGS FOR REFRACTORY ALLOYS. Ortner, Martin (Vitro Labs., West Orange, N. J.). Met. Soc. Conf., 30: 671-80(1966).

The deposition of coating particles on refractory metals by electrophoresis is described. Such coatings may be bonded to substrates without the necessity of diffusion treatments. (auth)

9062 REFRACTORY ALLOY COATINGS FOR SHORT TIME-ULTRA HIGH TEMPERATURES. Freedman, A. H.; Mikus, E. B. (Materials Research Group, Hawthorne, Calif.). Met. Soc. Conf., 30: 693-706(1966).

In brazing refractory metal alloys, expendable metal envelopes are maintained about the brazement to provide a clean atmosphere. Simplified coatings and coating procedures were developed to provide adequate oxidation protection of Ti brazing envelopes up to 2800°F and Ta envelopes up to 3300°F. Initial experiments established that there was no significant difference in the oxidation protection afforded by flame or plasma sprayed coatings of Al_2O_3−2.5 TiO_2. However, the flame spray method is more economical and has greater simplicity and portability. The use of other coatings is also described. (P.C.H.)

9063 ARC PLASMA COATINGS FOR REFRACTORY METALS. Jones, F. L.; Elkins, S. R. Jr.; Wilkins, B. Jr.; Barland, E. S. (Lockheed-Georgia Co., Marietta). Met. Soc. Conf., 30: 707-17(1966).

Procedures for deposition of protective coatings on refractory metal substrates through the use of arc plasma spraying is described. Studies showed that the coatings perform better under low pressures and high temperatures than at atmospheric pressure and high temperature because before significant oxidation of the substrate occurs, sufficient glass has formed in the coating. (P.C.H)

9064 SILICIDE COATINGS FOR TANTALUM AND TANTALUM-BASE ALLOYS. Hallowell, J. B.; Maykuth, D. J.; Ogden, H. R. (Battelle Memorial Inst., Columbus, Ohio). Met. Soc. Conf., 30: 737-53(1966).

Results of laboratory scale development of protective coatings for Ta and its alloys are described. The importance of interaction between the substrate and the coating system is demonstrated. Best results with silicide coatings were obtained when the substrate contained V. (auth)

9065 PROTECTING TANTALUM ALLOY AT 3500 DEG F IN AIR. Kallup, Charles; Castner, Stanley V. (Marquardt Corp., Van Nuys, Calif.). Met. Soc. Conf., 30: 755-64(1966).

Experience in the use of the Sn−Al coating for protection of Ta alloys up to 3500°F is described. (auth)

9066 OXIDATION-RESISTANT COATINGS FOR USE ON TUNGSTEN ABOVE 4000 DEG F. Stetson, A. R.; Ohnysty, B. (International Harvester Co., San Diego, Calif.). Met. Soc. Conf., 30: 765-78(1966).

Studies showed that W can be satisfactorily protected from oxidation up to 5000°F by two processes using ThO_2: plasma sprayed, graded coatings of ThO_2 and W; and pure ThO_2 troweled on a W wire mesh pinned to a W substrate. The graded coating demonstrated cyclic capabilities, and the troweled coating protected W to 5000°F. Both process coatings were tested successfully on flat and convex surfaces. (P.C.H.)

9067 THE EVALUATION OF OXIDATION PROTECTIVE COATINGS FOR THE Nb ALLOY FS-82. Pettyjohn, Robert R. (General Dynamics Corp., San Diego, Calif.). Met. Soc. Conf., 30: 779-94(1966).

Four of the most promising commercially available coatings for the Nb-base alloy FS-82 were evaluated to determine the degree of oxidation protection afforded by each coating. Bend, hardness, and oxidation tests were conducted and used as the primary evaluation criteria. Limited tensile and creep tests were also conducted. (auth)

9068 PROGRESS IN THE COATING OF REFRACTORY METAL FOIL. Moore, V. S.; Stetson, A. R. (International Harvester Co., San Diego, Calif.). Met. Soc. Conf., 30: 795-812(1966).

Methods for coating refractory metal alloys in foil form and the mechanical properties of the coated foils were studied. The alloys used were B-66 and TZM. Final screening tests included cyclic furnace oxidation at 1800, 2100, 2350, and 2500°F, low pressure plasma torch testing at 5 Torr, ductile-brittle transition temperature, diffusion studies at 2350 and 2500°F, creep at 2000 and 2500°F, and room temperature fatigue life. Although considerable deterioration in mechanical properties resulted, coating Nb alloy foils appeared most promising. (P.C.H.)

9069 COATED REFRACTORY METALS FOR HIGH-TEMPERATURE STRUCTURAL COMPONENTS. Rummler, D. R.; Lisagor, W. B.; Wichorek, G. R. (Langley Research Center, Hampton, Va.). Met. Soc. Conf., 30: 813-26(1966).

Studies were made on the use of refractory metals as structural materials in high-temperature oxidizing environments. The effects of coating application and subsequent high-temperature exposure on the tensile properties of D-36 for 11 silicide-based coatings are reported. In general, the tensile strength of the substrate was not severely affected from room temperature to 3000°F by the application of a protective coating. As a result of oxidation tests on a coated Mo alloy, a failure mechanism is proposed for silicide-based coatings. (P.C.H.)

9070 TUNGSTEN EROSION BY ROCKET EXHAUST CONSTITUENTS. Brown, D. A.; Gordon, G. M. (Stanford Research Inst., Palo Alto, Calif.). Met. Soc. Conf., 30: 829-42(1966).

Dynamic and static erosion of tungsten by rocket exhaust constituents was studied. Individual exhaust constituents that caused only negligible W erosion were: H_2, N_2, Al_2O_3, and HCl. Appreciable erosion was found to occur in: H_2O, CO_2, and HCl + Al_2O_3. At large values of CO/CO_2, low melting W_2C was formed by the reaction $2W + 2CO \rightarrow CO_2 + W_2C$. The type of W used did not significantly affect the observed erosion rates. (P.C.H.)

9071 INTERACTION OF IRON WITH MOLTEN URANIUM. Walter, C. M.; Kelman, L. R. (Argonne National Lab., Ill.). J. Nucl. Mater., 20: 314-22(Sept. 1966).

The rate of penetration of Armco iron by molten U, U–34 at. % Fe eutectic, and U–77 at. % Fe eutectic was investigated at 740 to 1300°C. This was done in an effort to understand the mode of penetration of U-base fuels through Fe-base claddings. The phenomenon of particular interest was a penetration rate reversal, i.e., decreasing rate with increasing temperature, between 1150 and 1244°C. Penetration rates at 1150°C were found to be 760 μm/sec in U, 690 μm/sec in U–34 at. % Fe, and 5.5 μm/sec in U–77 at. % Fe. At 1244°C these rates changed to 150 μm/sec in U, 130 μm/sec in U–34 at. % Fe, and 5.7 μm/sec in U–77 at. % Fe. The study showed that the penetration rate is related to the rate and mode of formation of UFe_2. The rate changes correlate well with the phases of the U–Fe equilibrium diagram. (auth)

9072 THE KINETICS OF OXIDATION OF PLUTONIUM METAL AND A PLUTONIUM–3.4 a/o ALUMINUM ALLOY AT TEMPERATURES FROM 140 DEG TO 550 DEG C. Schnizlein, J. G.; Fischer, D. F. (Argonne National Lab., Ill.). J. Electrochem. Soc., 114: 23-9(Jan. 1967).

The kinetics of oxidation of reactor grade Pu and ultrapure Pu were studied in O_2 and air at 140 to 550°C. Paralinear rate laws apply over the entire range with a change of mechanism between 300 and 400°C. At 140 to 300°C the process is postulated to be controlled by a compact layer of Pu_2O_3. Simultaneous growth of this layer and linear oxidation to PuO_2 results in paralinear kinetics whose rate constants are $k_{parabolic} = 1.6 \times 10^{15}$ [exp (–27,400/RT)] $(\mu g/cm^2)^2$/min and $k_{linear} = 1.6 \times 10^8$ [exp (–16,800/RT)] $(\mu g/cm^2)$/min. Above 400°C the oxide produced is more protective and is postulated to include a layer of $PuO_{1.6}$ consistent with phase studies. Paralinear kinetics are followed with simultaneous rate constants $k_{parabolic} = 1.8 \times 10^{12}$ [exp (–22,500/RT)] $(\mu g/cm^2)^2$/min and $k_{linear} = 8.8 \times 10^9$ [exp (–26,400/RT)] $(\mu g/cm^2)$/min. The presence of moisture had no effect above 215°C, but caused a marked increase in the oxidation at lower temperatures. As little as 180 ppM moisture caused the linear rate at 190°C to accelerate an order of magnitude. The presence of 3.4 at. % Al in Pu reduced the oxidation rates at temperatures below 400°C but only slightly reduced oxidation rates at higher temperatures. (auth)

9073 OXIDATION OF ZIRCALOY-2 AT 600° ~ 800°C. Fukushima, Eiji (Tokyo Shibaura Electric Co., Ltd.). Nippon Kinzoku Gakkaishi, 30: 910-15(Oct. 1966). (In Japanese).

The oxidation of zirconium and its alloys was studied by separating the total weight increase into the formation of oxide scales and the oxygen solution into the substrate. The growth of oxide scales was estimated from the measurement of the electric capacity. It was found that the oxidation of Zircaloy-2 at ~600 to 800°C is proportional to the cube root of oxidation time until the breakaway occurs. According to the electric capacity measurement of specimens, the increase of the oxide scale thickness is also nearly proportional to the cube root of oxidation. The higher the oxidation temperature, the more oxygen dissolves into the substrate. According to radiochemical analysis of the amount of oxygen dissolved in the substrate at 800°C, the contribution of the oxide scale formation to the total weight gain is 93 to 95% in the initial period of oxidation (within ~70 to 100 min). Thereafter, the contribution of the dissolved oxygen increases rapidly and that of the oxide scale formation increases less. (auth)

9074 OXIDATION OF METALS. Hauffe, Karl. New York, Plenum Press, 1965. 460p. $19.50.

Translated from Oxydation von Metallen und Metallegierungen by Karl Vorres.

An explanation of interrelations of crystal defects and diffusion processes in ionic, covalent, and metallic crystals, presented as the basis of the theory of tarnishing, is given; and the interplay between the diffusion of reacting species and the electrical field set up across tarnish film, with a basic derivation of the parabolic rate law, is discussed. Topics considered are: catastrophic oxidation, successive oxidation reactions, the occurrence of multiphase oxidation products, the internal oxidation of alloys, passivation of metals, electrolytic formation of anode products, and methods of measuring oxidation behavior. Tables of diffusion parameters for self-diffusion for several alloys and inorganic compounds are given. (D.H.M.)

Preparation and Fabrication

Refer also to abstracts 8268 and 9146.

9075 (AECL–2583) TECHNIQUES FOR HOT-PRESS-BONDING DISSIMILAR METAL COMBINATIONS. Watson, R. D. (Atomic Energy of Canada Ltd., Chalk River (Ontario)). May 1966. 20p. Dep. mn. AECL $1.00.

Hot-press techniques were used to join Zircaloy-2, stainless steel, and mild steel to Al. Joints of 304 stainless steel and Al, produced by this method were used in an experimental fuel rod, and joints of Al and Zircaloy-2 were used in the construction of a component indicator facility and 8 neutron flux detector rods for the NRU reactor. (P.G.C.)

9076 (AECL–2813) BRAZING OF ZIRCALOY IN NUCLEAR FUEL. Paper 2/5. Bates, K. T. (Canadian Westinghouse Co. Ltd., Port Hope (Ontario). Atomic Fuel Dept.). Sept. 1966. 14p. (CONF-660926–3). Dep. mn. AECL $0.50.

From International Nuclear Industry Fair and Technical Meetings, Basel, Switzerland.

A braze alloy (Zr + 5 wt % Be) is being used in Canada for the fabrication of Zircaloy-clad fuel. Development of the process and some of the problems which were overcome are described. Present day manufacturing techniques, corrosion data, and irradiation experience are presented. (auth)

9077 (AECL–2814) RESISTANCE WELDING OF ZIRCALOY END CLOSURE JOINTS. Bates, K. T. (Canadian Westinghouse Co., Ltd., Port Hope (Ontario). Atomic Fuel Dept.). Oct. 1966. 14p. (CONF-660926–4). Dep. mn. AECL $0.50.

From International Nuclear Industry Fair and Technical Meetings, Basel, Switzerland.

The resistance welding of Zircaloy has been adopted by Canadian fabricators to produce low cost, high quality fuel on a production scale. A process for resistance welding end closure joints of tubular fuel elements is described. An outline of the process development is given together with description of present day production methods, an assessment of quality and irradiation experience. (auth)

9078 (BMI–X–412) EXPLOSIVE WELDING DUPLEX ZIRCALOY–ALUMINUM TUBING. Summary Report. Porembka, S. W.; Wittman, R. H.; Carlson, R. H. (Battelle Memorial Inst., Columbus, Ohio). Oct. 26, 1966. Contract W-7405-eng-92. 46p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The explosive welding of Al liners in Zircaloy-4 tubing was achieved by both mandrel and external die approaches. The use of a low-detonation-velocity explosive provided improvement in the welding of mandrel assemblies because of the reduced problems with shock damage effects in the mandrel. Welding with mandrel assemblies was found to be dependent on the uniformity of assembly and explosive powder loading; factors which did not lend themselves to precise control. The external die welding approach in conjunction with the low-detonation-velocity explosive yielded highly successful results in a limited series of experiments which included a 3-ft-long duplex tube. Explosive welds obtained by the two methods showed that the mandrel approach resulted in a greater amount of intermediate phase at the weld interface for the conditions studied. The results of this study demonstrate that the external die method would be more adaptable to welding long duplex tube lengths. (auth)

9079 (EURAEC–1668) STUDY OF THE AUSTENITIC GRAIN GROWTH OF FIVE STEELS UNDER THE INFLUENCE OF HEAT CYCLES SIMULATING VERTICAL SLAG WELDING CONDITIONS. EXECUTION OF FURTHER CYCLES. Special Report No. 13, April 1–June 30, 1966. (Chantiers de l'Atlantique Saint-Nazaire (France)). Contract 056-61-12RDF. 20p. (EUR-2860). Dep. mn. CFSTI $1.00 cy, $0.50 mn.

Work Performed under United States–Euratom Joint Research and Development Program.

A study (Study No. 985) was made of grain growth during heat cycles in five Mn–Mo and Mn–Ni–Mo steels: Wel Monix, W B 35, P M 24, 15 MDV 4.05, and 1.2 MD 0.7. The heat cycles were carried out at different heating rates, and specimens were examined by hot and standard microscopy. The results at 1150°C are compared with those at 1250°C (Study No. 960), and it is concluded that the tests do not permit classification of the steels in order of overheating resistance. The grain of W B 35 steel is perhaps a little larger than that of the others. The heating rate has no effect on the final grain size. (D.L.C.)

9080 (EURAEC–1756) STUDY OF THE BASE METAL INTENDED FOR RESEARCH ON THE BRITTLE FRACTURE OF LARGE WELDMENTS. Study of Anisothermal Stress-Relief on AMMO Steel. Quarterly Report No. 10, July 1–September 30, 1966. (Institut de Recherches de la Siderurgie, St. Germaine-en-Laye (France)). Nov. 24, 1966. Contract 031-64-5 TEEF(RD). 10p. (EUR–3311). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Work Performed under United States–Euratom Joint Research and Development Program.

Magnetic analysis was conducted on the transformations in AMMO steel during heat cycles simulating a welding cycle, and graphs are presented for temperatures of 900 to 1250°C. Stress-

relief heat cycles were applied to AMMO steel in the initial state and in the pretreated state simulating the heat-affected zone of a weld. Stress–temperature graphs are presented for treatment temperatures of 900 and 1100°C. (D.L.C.)

9081 (GEMP-61) HIGH-TEMPERATURE MATERIALS PROGRAM PROGRESS REPORT NO. 61. (General Electric Co., Cincinnati, Ohio. Nuclear Materials and Propulsion Operation). Sept. 30, 1966. Contract AT(40-1)-2847. 174p. Dep. mn. CFSTI $5.00 cy, $1.00 mn.

Progress is reported in fifteen sections. Separate abstracts were prepared for thirteen sections. Sections for which no abstracts were prepared are concerned with plans for research on refractory-metal alloys, and plans for a critique-type review of pressure vessel material development. (J.R.D.)

For abstracts of individual sections see: 9049, 9082, 9083, 9137–9139, 9185, 9198, 9199, 9237, 9249, 10215, and 10216.

9082 (GEMP-61, pp 55-76) REFRACTORY-METAL ALLOY RESEARCH AND DEVELOPMENT. Funston, E. S.; Tarr, C. O. (General Electric Co., Cincinnati, Ohio. Nuclear Materials and Propulsion Operation).

Processes are described for production of Mo sheet from high-purity Mo powder compacts and for purification and processing Mo–Re–W alloy sheets in which weld porosity is at a minimum. Mo powders were produced both by fluoride dissociation and H_2–water vapor treatment. Fabricability of both types of Mo sheets is discussed as is the correlation between the presence of trace alkaline metals and weld porosity in refractory metals. Fabrication techniques for drawing small seamless tubes of refractory metals are discussed. (P.G.C.)

9083 (GEMP-61, pp 111-18) ADVANCED LONG-LIFE REACTOR FUEL CLADDING AND STRUCTURAL MATERIALS DEVELOPMENT. Collins, J. F.; Robertshaw, F. C. (General Electric Co., Cincinnati, Ohio. Nuclear Materials and Propulsion Operation).

As part of a research program to develop fuel cladding and structures for fast breeder reactors, diffusion-strengthened Al–Cr–Fe-base alloys were studied. The alloy was prepared in powder form by atomization from the molten state, compacted and hot extruded into solid form. The alloy was found to remain essentially stable with respect to hardness and microstructure after aging for periods up to 100 hours at 450 to 1100°C. Oxidation resistance was comparable to that of the melted and wrought alloy. (P.G.C.)

9084 (LA-DC-7867) MODIFIED TECHNIQUES FOR PREPARING SPECIMENS OF ALPHA-ACTIVE MATERIALS. Douglass, Dana L. (Los Alamos Scientific Lab., N. Mex.). [nd]. Contract W-7405-eng-36. 10p. (CONF-660806-3). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

From Electron Microscope Society of America, 24th Annual Meeting, San Francisco, Calif.

A description is given of certain simple modifications of standard techniques used on nonradioactive materials to prepare Pu for electron microscopy. By using standard methods, Pu can be electrochemically thinned and then examined by transmission electron microscopy. Similarly, two-step modified replication procedures are equally applicable for use with bulk Pu samples. (W.D.M.)

9085 (NASA-TN-D-3772) EXTRUSION OF 1/2- AND 3/8-INCH-DIAMETER, THIN-WALL TUNGSTEN TUBING USING THE FLOATING-MANDREL TECHNIQUE. Blankenship, Charles P.; Gyorgak, Charles A. (National Aeronautics and Space Administration, Cleveland, Ohio. Lewis Research Center). Dec. 1966. 26p. CFSTI $3.00 cy, $0.65 mn.

Fabrication of small-dia, thin-wall W tubing by hot extrusion over a floating mandrel was investigated. Variables studied included extrusion temperature, initial density of the W, and composition of the canning material. Successful extrusion of ½-in.-dia tubing over 0.4-in.-dia mandrels was accomplished at 3000 to 4000°F. Tubing of ⅜-in. dia was extruded successfully over 0.3-in.-dia mandrels at 4000°F. Nominal wall thicknesses were 0.020 in., and the maximum usable length was 5 ft. At 3000 to 4000°F, tubing extruded from W cylinders having a density near 80% theoretical or greater was fully dense. At 4000°F, fully dense tubing was extruded from approximately 68% dense cylinders. For the best ⅜- and ½-in.-dia tubing, wall thicknesses were within ±0.001 and ±0.002 in., respectively, and the dia were within ±0.005 in. At 3500°F, the tensile strength of the extruded tubing, 8300 to 9600 lb/in.^{2} was comparable to that of wrought sintered W. Tubing internally pressurized at 3500°F failed at an average tangential stress ranging from 9500 to nearly 11,000 lb/in.^{2} (auth)

9086 (NASA-SP-5026) BRAZING AND BRAZING ALLOYS. A Bibliography. (National Aeronautics and Space Administration, Washington, D. C.). 1966. 52p. CFSTI $3.00 cy, $0.65 mn.

Information on brazing and brazing alloys is presented in the form of 107 abstracts selected from literature published from March 1961 to December 1965. Subjects covered, which have industrial application, are brazing alloys and metals, basic factors, fabrication methods, methods development, testing, and evaluation. (P.G.C.)

9087 (NLCO-989) PRODUCTION OF MARK VE INNER AND OUTER INGOTS BY REVISED CASTING PROCEDURES. Maynord, J. R.; Fink, W. M. (National Lead Co. of Ohio, Cincinnati). Jan. 1967. Contract AT(30-1)-1156. 14p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

A change in casting procedures was proposed to reduce or eliminate casting voids in 8- and 9-inch-diameter, solid uranium ingots. To determine the value of the revised procedure, ten 9-inch-diameter Mark VE outer ingots and ten 8-inch-diameter Mark VE inner ingots were cast using the proposed changes. A comparison of the test ingots with routine production ingots revealed that the revised casting procedure improved soundness significantly. (auth)

9088 (ORNL-P-2615) CODES, SPECIFICATIONS AND ACCEPTANCE STANDARDS FOR WELDMENTS. Miller, Edward C. (Oak Ridge National Lab., Tenn.). Sept. 28, 1966. Contract W-7405-eng-26. 19p. (CONF-660936-1). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

From Symposium on Weld Imperfections, Palo Alto, Calif.

A general description of problems confronting industry, users, and governmental regulatory agencies in development of meaningful and workable welding codes and standards is presented. Necessity for correlation between hydrostatic, radiographic, and ultrasonic tests, and magnetic particle and penetrant examination is stressed. The limitations of each method of inspection are appraised. (P.G.C.)

9089 (SEP-40(Del.)) THE POWDER METALLURGICAL PRODUCTION OF ZIRCONIUM–URANIUM CORE MATERIALS FOR A WATER-COOLED REACTOR. Kalish, Herbert S.; Hausner, Henry H. (Sylvania Electric Products Inc., Bayside, N. Y.). Mar. 12, 1951. Contract AT(30-1)-Gen-366. 50p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Homogeneous U–Zr alloy fuel elements were produced by powder metallurgy at temperatures not exceeding 1300°C. The metallic powders were produced from the hydrides, compacted, and sintered in vacuo at 4×10^{-5} mm. The alloys were ductile, had bright, clean surfaces, and could be clad without machining. The U–Zr alloy cores were clad by hot rolling at about 900°C in a Zr picture frame structure. Advantages of the method are ease of fabrication, conversation of expensive materials, and facile assembly with other materials such as Zr. (P.G.C.)

9090 (ORNL-tr-1402) ELECTRON BEAM ZONE MELTING OF TUNGSTEN AND MOLYBDENUM. Barthel, J.; Petri, R. Translated for Oak Ridge National Lab., Tenn., from a German report. 21p. Dep. mn. JCL $2.60 fs, $0.83 mf.

A summary is given on findings and unanswered problems of electron beam zone melting of W and Mo. The melting behavior of various raw materials, their effects on the attainable purity, the crystallization course, and the distribution of impurities are discussed along with the separation and the purity of zone-melted crystals as a function of melting conditions are discussed. (auth)

9091 (ORNL-tr-1403) DEVELOPMENT OF EQUIPMENT FOR SINGLE CRYSTAL GROWTH OF HIGH-MELTING POINT METALS. Barthel, J.; Scharfenberg, R. Translated for Oak Ridge National Lab., Tenn., from a German report. 15p. Dep. mn. JCL $1.60 fs, $0.80 mf.

Single crystals of high-melting-point metals are preferentially grown by electron beam zone melting. The influence of the electron beam sources utilized and the direction of solidification on the stability of the zone and on the geometrical shape of the solid-liquid interface, as well as of the grown crystals, is discussed. Systems of optimum focussing were found which guaranteed a stable growth of the crystals. In addition, experiments with radioactive isotopes showed that an insignificant W contamination in the test rod took place by the use of W cathodes. By means of a suitable pretreatment and a specially developed holder, a stable position of the W cathode could be obtained in the focussing system. (auth)

9092 PRODUCTION AND INVESTIGATION OF NIOBIUM–ZIRCONIUM ALLOY SUPERCONDUCTING WIRE. Baranov, I. A.; Shmulevich, R. S.; Karasik, V. R.; Kurganov, G. B. pp 72-5 of Metallovedenie i Metallofizika Sverkhprovodnikov. Savitskii, E. M.; Baron, V. V. (eds.). Moscow, Izdatel'stvo Nauka, 1965. (In Russian).

Results of work on a semi-industrial level on obtaining wire from Nb–Zr alloys are presented. Niobium of electronic-beam melt and zirconium iodide in the form of rods 10 to 14 mm in

diameter were used as initial materials. The ingot was twice remelted; the first remelt was conducted with maximum speed for the purpose of decreasing zirconium waste. Hardness of cast alloys was checked in ingots after first and second remelting. Homogenized annealing of ingots at a temperature of 1200° during 24 hours was tested. A value for the critical current density of 4.6×10^4 A/cm^2 was determined for alloys of Nb–25 to 27% Zr (M.H.R.)

9093 CRITICAL STRAIN AND THE GROWTH OF LARGE GRAINS OF THE Pu–1 WT. PERCENT Ga ALLOY. Moment, R. L. (Dow Chemical Co., Golden, Colo.). Contract AT(29-1)-1106. J. Nucl. Mater., 20: 341-3(Sept. 1966).

Experiments were performed to determine the critical plastic strain necessary for recrystallization in the growth of large grains of Pu–Ga alloy. A bend test on rolled strips and tests on cast rods indicated the critical strain to be close to 2%. This result was then applied in an attempt to grow a single crystal. Annealing of a recrystallized strip strained 2% in tension for three days at 500°C resulted in a grain 7½ by 3½ mm. After an additional annealing of seven days the crystal measured 9½ by 2 mm. A few other large grains (1 to 2 mm in dia) were formed in the same sample. (A.G.W.)

9094 PREPARATION, MELTING POINT, AND THERMAL EXPANSION OF PROTACTINIUM METAL. Marples, J. A. C. (Atomic Energy Research Establishment, Harwell, Eng.). pp 39-43 of Physico-Chimie du Protactinium. Paris, Centre National de la Recherche Scientifique, 1966.

A small quantity of protactinium metal was prepared by reducing the fluoride with calcium. The melting point was determined as 1575 ± 20°C and the structure was confirmed to be body centered tetragonal. The variation of the lattice parameters with temperature was studied and a possible phase transition to body centered cubic at 1170 ± 20°C was investigated. (auth)

9095 COLUMBIUM METAL BY THE ALUMINOTHERMIC REDUCTION OF Cb_2O_5. Wilhelm, H. A. (Iowa State Univ., Ames); Schmidt, F. A.; Ellis, T. G. J. Metals, 18: 1303-8 (Dec. 1966). (IS–1304).

A practical process for the preparation of high-purity ductile Nb metal consists of reducing Nb_2O_5 with Al powder in a bomb-type reduction. Al, O_2, N_2, and Fe impurities can be removed in subsequent treatments by volatilization. Purified Nb sponge obtained by heating to 2000 or 2200°C can be converted to massive ductile metal by nonconsumable arc melting. A duplex melting scheme in which the vacuum-arc-cast ingot is remelted in an electron-beam furnace yields high-purity ductile Nb. (A.G.W.)

9096 STUDIES ON THE WELDING OF REACTOR-USE BORON STEELS. Yosetsu Gijutsu, 13: No. 11, 53-65(Nov. 1965). (In Japanese).

Two kinds of boron steel (1.80 to 1.85%, 15 mm; 2.00%, 6 mm), boron stainless steel (1.81%, 8 mm), and stainless steel (9 mm) were tested for bead cracking of the T-shaped fillet welds. For the boron steel (6 mm) with low-hydrogen welding rods of the ferrite series and the boron stainless steel with rods of the austenite series, the cracking was completely eliminated, but for the boron steel (15 mm) and the welded boron stainless steel with mild steel, the cracking could not be removed. Boron stainless steel (1.6%; 2.00%) was tested for tension corrosivity in 42% magnesium chloride solution. The anti-tension corrosivity of the boron stainless steel was better than that of 18-8 stainless steel. The boron stainless steel (1.6%, 8 mm; 2.00%, 8 mm) welded by the TIG and shielded-arc methods was tested for anti-corrosivity in hot water by the bending test. Its anti-corrosivity was inferior to SS304, but the corrosiveness of the welded part was not always especially large. (NSA of Japan)

9097 COMPARATIVE WELDABILITY OF REFRACTORY METAL ALLOYS. Lessmann, G. G. (Westinghouse Electric Corp., Pittsburgh). Weld. J. (N. Y.), 45: 540s-60s(Dec. 1966).

Metallurgical considerations are emphasized in a comprehensive evaluation of the weldability of high-temperature alloys. Alloys studied included eight Nb-base alloys, two high-strength Ta alloys, two W alloys, and unalloyed W. Welding was treated as a variable thermal process in developing the experimental procedures and in evaluating results. Considerable success was realized in using a thermal analysis to follow the responses of Nb alloys to welding. The importance of balance between matrix and grain boundary strength in high-temperature applications was demonstrated. The factors causing weld porosity and the effect of porosity were evaluated. Satisfactory weld atmosphere controls were developed. Excellent weldability was demonstrated by the Ta alloys, decreasing and variable weldability by the Nb alloys, and generally poor weldability by W alloys. (A.G.W.)

9098 MECHANICAL BEHAVIOR OF REFACTORY-METAL ALLOYS. Schmidt, Fritz F.; Bartlett, Edwin S. Battelle Tech. Rev., 16: No. 1, 8-14(Jan. 1967).

The metallurgical behavior, properties, and uses of Mo, Nb, Ta, and W and their alloys are reviewed. Methods for fabricating the alloys and pertinent research trends are also described. (J.G.B.)

9099 METHOD AND DEVICE FOR CONSOLIDATING REFRACTORY METAL POWDERS. (to U. S. Atomic Energy Commission). British Patent 1,050,772. Dec. 7, 1966. Priority Date June 3, 1964, United States.

Methods and equipment are described for compacting refractory metal powders into desired shapes using magnetic fields produced in coaxial conductors. Opposing magnetic fields in the coaxial conductors are used to consolidate refractory metal powders into tubular rods and other shapes. High pressures over long lengths can be attained using this process. (J.R.D.)

9100 EMBRITTLEMENT-RESISTANT IRON–CHROMIUM–ALUMINUM–YTTRIUM ALLOYS. Wukusick, C. S. (to U. S. Atomic Energy Commission). U. S. Patent 3,298,826. Jan. 17, 1967.

Preparation of a steam corrosion-resistant alloy of Fe, Cr, Al, and Y is described which consists of 0 to 15 wt % Cr, 0.5 to 12 wt % Al, 0.1 to 3% Y, and the balance Fe. (AEC)

9101 PREPARATION OF URANIUM–NIOBIUM ALLOYS BY CO-REDUCTION. Johnston, R. A.; Golliher, W. R. (to U. S. Atomic Energy Commission). U. S. Patent 3,301,667. Jan. 31, 1967.

A method is given for synthesizing a U–Nb alloy. In the method, an essentially adiabatic bomb co-reduction is effected of a mixture of UF_4 and K_2NbOF_5 0 to 50%, by weight, (based on the Nb of Nb_2O_5) or, the reaction product resulting from a reaction between NbF_5 and a fluoride salt selected from CsF, LiF, BaF_2, CaF_2, UO_2F_2, KF, and MgF_2. (AEC)

9102 REFRACTORY METALS AND ALLOYS III: APPLIED ASPECTS. Proceedings of the Third Technical Conference, Los Angeles, California, December 9–10, 1963. Jaffee, Robert I. (ed.). Met. Soc. Conf., 30: 1-996(1966). (CONF-373–).

Seventy-eight articles are included; separate abstracts were prepared for 64. Thirteen articles on fabrication, corrosion, properties, and uses of refractory metals and alloys were previously abstracted in NSA as: 18: 8769, 10572, 12610, 14355, 14420, 14421, 14422, 14423, 14456, 16447, and 24091, and 20: 27466 and 29682. One article on fabrication of high-temperature refractory-alloy antennas was not included in NSA. (P.C.H.)

For abstracts of individual papers see: 9056–9070, 9103–9134, and 9145–9161.

9103 FORGING OF TUNGSTEN COMPONENTS. Evans, F. D. (Aerojet-General Corp., Sacramento, Calif.). Met. Soc. Conf., 30: 37-47(1966).

The evolution of W forging processes is described, beginning with simple compaction and extending to current fabrication methods involving complex production techniques to obtain a desired microstructure. Preliminary results on studies on the relation of grain size to mechanical properties and tensile transition indicate that continued advancement still can be made. In fact, room temperature ultimate strength values exceeding 175 ksi and transition temperature ranges of 100 to 200°F are anticipated. (P.C.H.)

9104 FORMING OF THE REFRACTORY METALS. Wagner, E. M.; Buckingham, E. C.; Straub, C. Curt (Super Metals Co., Sante Fe Springs, Calif.). Met. Soc. Conf., 30: 57-66(1966).

The refractory metals, W, Mo, Nb, and Ta can be fabricated at elevated temperatures by the same basic processes as are used to form the common metals, provided alterations are made to accommodate the properties peculiar to the refractory metals. Primary processes include brake, roll, open and closed die forming; warm and hot forging; swaging; deep drawing; ironing; blanking; and shearing. Secondary processes include welding, brazing, and heat treating. The major requirements for a refractory metals forming shop are tooling that can be adapted for heating, a broad background in metal fabrication, adequate temperature control equipment, an understanding of the basic metallurgy of the refractory metals, and an open minded and inquisitive approach. (auth)

9105 THE FORMING OF A Nb–10W–10Ta ALLOY. Perryman, J. T. (Stauffer Metals Div., Richmond, Calif.). Met. Soc. Conf., 30: 67-72(1966).

A process is described for fabrication of cast Nb–10W–10Ta alloy ingots into large-diameter rings by forging and ring rolling. Crack propagation was found not to be a serious problem in hot working this alloy. Tensile properties comparable to sheet material were obtained on the rolled rings. (P.C.H.)

9106 PRODUCTION OF REFRACTORY-METAL TUBE SHELLS BY EXTRUSION AND FLOW-TURNING TECHNIQUES. McDonald, R. E.; Leitten, C. F. Jr. (Oak Ridge National Lab., Tenn.). Met. Soc. Conf., 30: 85-98(1966).

The feasibility of manufacturing refractory-metal alloy tube

shells both by high-temperature extrusion and flow-turning techniques was investigated. Unlike most conventional tube-shell extrusion methods, a floating-mandrel technique is being used to extrude uncanned tube shells of Mo and W alloys. This technique was selected since the volatile oxides of these refractory metals minimize contamination by air during hot working. Satisfactory tube shells of Mo and Mo-base alloys were extruded by this technique using a reduction ratio of 8.8 to 1 and a temperature range of of 1590 to 2065°C. Flow turning, a low-temperature process, was explored as a tube-shell production technique for refractory metals, such as Nb and Ta, which are easily contaminated by air at elevated temperatures. Procedures were developed for flow turning hollow cylinders of the Nb–1% Zr alloy prepared from both wrought bar stock and cast ingots. (auth)

9107 CONSOLIDATION AND APPLICATION OF TUNGSTEN–26 PERCENT RHENIUM ALLOY SEAMLESS TUBING. **Hall B. F. Jr.; Spooner, N. F. (Hoskins Manufacturing Co., Detroit). Met. Soc. Conf., 30: 99-111(1966).**

Specialized techniques for the preparation of the initial tubing blank, use of a "filled billet" concept as a consolidation medium, development of a chemical drilling method for mandrel removal, and special adaptations of conventional tube reduction methods have enabled production of a variety of seamless tube sizes of W–26% Re alloy. Commercially available forms and quality are discussed. High temperature extrusion of powder metallurgy billets is discussed as a means of preparing breakdown tubes for subsequent swaging and drawing operations. Welding and brazing methods are suggested, and filler metals are recommended for various compatibility considerations. (auth)

9108 PARAMETERS FOR THE PRODUCTION OF REFRACTORY-METAL TUBING BY THE VAPOR DEPOSITION PROCESS. **Heestand, R. L.; Leitten, C. F. Jr. (Oak Ridge National Lab., Tenn.). Met. Soc. Conf., 30: 113-23(1966).**

A method for producing tungsten tubes and various tubular shapes by reduction of WF_6 by H_2 was developed to provide either a finished product or material for subsequent working. Studies were made to determine the deposition conditions of pressure, temperature, flow rates, and gas ratios that would produce a dense, uniform deposit at a rate suitable for fabrication of parts in a reasonable time. The limits of deposition most thoroughly examined were at pressures of 10 to 20 mm, temperatures of 500 to 950°C, and H–W mole ratios of 70:1 to 140:1. (P.C.H)

9109 PRODUCTION OF DOUBLE EXTRUDED HEAVY WALL MOLYBDENUM TUBING. **Hicks, R. H. (Universal Cyclops Steel Corp., Bridgeville, Pa.). Met. Soc. Conf., 30: 137-49(1966).**

The production of heavy walled vacuum arc-cast Mo tubes by extrusion is described. A double extrusion practice was developed consisting of back extrusion to achieve the inside diameter, followed by forward extrusion to produce the outside diameter. Such extruded rings are suitable for subsequent ring rolling and mandrel forging applications. (auth)

9110 FABRICATION AND PROPERTIES OF SEAMLESS TUNGSTEN TUBING. **Loewenstein, P.; Hunt, J. G.; Jenkins, R. G. (Nuclear Metals, Inc., Concord, Mass.). Met. Soc. Conf., 30: 151-67(1966).**

A process for the production of seamless W tubing is described. The process consists of the extrusion of sintered powder sleeves at elevated temperatures to sizes close to the final dimension. The tubing is finished by warm drawing. A size range of .100 in. dia to $1\frac{1}{2}$ in. dia has been fabricated. A preliminary evaluation of properties of the extruded tubes is given. (auth)

9111 BRAZING OF TANTALUM AND ITS ALLOYS. **Torti, M. L.; Douglass, R. W. (National Research Corp., Newton, Mass.). Met. Soc. Conf., 30: 171-82(1966).**

Satisfactory brazed lap joints between stainless steel and Ta or the Ta–10W alloy were obtained with pure Cu or several commercial Ag–Cu base brazing alloys with no surface preparation other than cleaning. Stainless steel was also joined to the Ta–10W alloy by welding; however, it is considered necessary that only the stainless steel is molten during welding. (P.C.H.)

9112 REFRACTORY METAL BRAZING ALLOY DEVELOPMENT. **Kaarlela, W. T. (General Dynamics/Fort Worth, Tex.). Met. Soc. Conf., 30: 183-98(1966).**

Experimental development of refractory brazing alloys for joining refractory metals Nb, W, and Mo is described. The use of such metals in producing brazed refractory metal sandwich panels was demonstrated. More than twenty 6 × 6 in. and 12 × 12 in. brazed sandwich panels for hot monocoque structures have been successfully brazed and tested. (P.C.H.)

9113 ALLOY SYSTEMS FOR BRAZING OF NIOBIUM AND TUNGSTEN. **Young, W. R. (General Electric Co., Evendale, Ohio). Met. Soc. Conf., 30: 199-210(1966).**

High-temperature brazing materials for Nb and W, suitable for service at 2500°F for Nb alloys and to 3000°F for the W alloys are described. Brazing alloys that exhibit tensile-shear strengths in excess of 7000 psi at 2500°F were also developed. In all cases, metallurgical compatibility between the braze alloys and parent materials was the principal criterion of alloy selection. The binary alloy AS-517 (Nb–2.2B) produced excellent strength brazements with unalloyed W. (P.C.H.)

9114 THE BRAZING OF NIOBIUM ALLOY FOILS. **Smeltzer, C. E.; Metcalfe, A. G. (International Harvester Co., San Diego, Calif.). Met. Soc. Conf., 30: 211-25(1966).**

The development and application of reactive brazing alloys for Nb alloy foil brazing was found to be the most promising approach to circumvent the problems of erosion and embrittlement associated with brazing using conventional high-temperature brazing alloys. (auth)

9115 JOINING MOLYBDENUM TO TUNGSTEN. **Smith, J. T. (Avco Corp., Wilmington, Mass.). Met. Soc. Conf., 30: 239-48 (1966).**

Basic principles and experimental procedures for joining dissimilar metals by a liquid alloying, diffusion bonding method are reported. Several electric propulsion engines, made of W and Mo components, have been fabricated using this technique. The engines have been operated to join temperatures of 2000°C with no failures. (P.C.H.)

9116 EXOTHERMIC BRAZING OF REFRACTORY METALS. **Long, Roger A. (Whittaker Corp., San Diego, Calif.). Met. Soc. Conf., 30: 249-58(1966).**

Brazing of refractory metals and alloys was accomplished without the necessity of inert atmospheres through the use of exothermic reactions. (auth)

9117 JOINING METHODS FOR POROUS REFRACTORY METALS. **Kirkpatrick, M. E. (TRW Space Technology Labs., Inc., Redondo Beach, Calif.). Met. Soc. Conf., 30: 259-73(1966).**

Fabrication methods and techniques for the preparation of ion emitter modules which require a high temperature, leak-free bond between a porous W ionizer and a refractory metal plenum chamber are discussed. Formation of bonds between or in contact with porous metallic bodies poses numerous problems with regard to selection of the materials and methods used in brazing or diffusion bonding. Studies were made on: ionizer permeability due to pore infiltration by braze materials; elevated temperature dimensional stability of porous structure due to presence of braze materials; electronic work function of porous ionizer due to sublimation and/or diffusion of braze materials; and mechanical integrity near the bond zone due to volumetric inequalities caused by solid solution formation. Several braze and braze-diffusion bonding techniques were analyzed and evaluated through laboratory investigations and the resulting data are presented. (auth)

9118 BRAZING AND CLADDING RESEARCH ON REFRACTORY METALS FOR USE IN EXTREMES OF ENVIRONMENTS. **Bertossa, Robert C. (Pyromet Co., San Carlos, Calif.). Met. Soc. Conf., 30: 275-88(1966).**

The principles of brazing and cladding refractory metals are described. The use of such procedures in several typical applications of refractory metals is illustrated. (auth)

9119 HOT PRESSING OF TUNGSTEN POWDER. **White, J. E.; Jurkowitz, M. M. (Aerospace Corp., El Segundo, Calif.). Met. Soc. Conf., 30: 291-4(1966).**

A hot pressing study was conducted on three grades of W powder to delineate the effects of a dispersed second phase and initial powder particle size on the hardness, density, and grain size of the final product. Included were two grades of pure W with a 2-μ and 20-μ average particle size. The third was a 4-μ W powder containing 1 vol. % ThO_2. (auth)

9120 FABRICATION OF TUNGSTEN AND TUNGSTEN COMPOSITES BY THE GAS-PRESSURE-BONDING PROCESS. **Hodge, E. S.; Gripshover, P. J.; Peterson, J. H. (Battelle Memorial Inst., Columbus, Ohio). Met. Soc. Conf., 30: 319-32 (1966).**

The gas-pressure-bonding process has been developed for the solid-state bonding and simultaneous compaction and bonding of W composites. A brief description of the process, its advantages, and its applications is presented. (auth)

9121 PRELIMINARY WELDABILITY EVALUATIONS OF TANTALUM ALLOYS. **Krammer, P. A.; Monroe, R. E.; Martin, D. C. (Battelle Memorial Inst., Columbus, Ohio). Met. Soc. Conf., 30: 365-77(1966).**

The weldabilities of nearly 100 Ta binary or ternary solid-solution alloys and dispersion-strengthened alloys were evaluated. Room temperature bend ductility was used as the principal measure of weldability; however, more extensive evaluations were

made of binary and ternary Ta alloys in the Ta–W–Mo system. Although most of the alloys could be joined by fusion welding, the ductilities of almost all resulting welds were low. With the present state of the art, room temperature ductile welds in the Ta alloys studied can be achieved only by sacrificing high-temperature strength. (auth)

9122 JOINING TUNGSTEN BY CHEMICAL VAPOR DEPOSITION. Disckind, M. J. (Martin Co., Orlando, Fla.). Met. Soc. Conf., 30: 379-92(1966).

A study was made of some of the parameters involved in joining 0.020 in. tungsten sheet by chemical vapor deposition. The joint was formed by tungsten metal from the reduction of tungsten hexafluoride by hydrogen at metal temperatures of 1000 to 1400°F. It was found that the parameters of deposit thickness (X), time (t), and absolute temperature (T), could be related by $\log X/t = C - B/T$ in two separate regimes (constants C and B different), from 1000 to 1200°F, and from 1200 to 1400°F. The deposits were characterized by elongated grains normal to the substrate, with coarseness increasing with deposition temperature. Large nozzles, with the same flow rates as small nozzles ($^{5}/_{64}$ in. vs 0.010 in.) at a given temperature, provided considerably coarser grains. Joint geometries were critical in obtaining sound deposits. High depth-to-width ratios of butt-joint gaps do not appear and double V bevels, sound deposits can be made readily. (auth)

9123 MICROSTRUCTURES OF SOLID-STATE-BONDED MOLYBDENUM AND TUNGSTEN JOINTS. D'Annessa, A. T. (Lockheed-Georgia Co., Marietta). Met. Soc. Conf., 30: 393-409 (1966).

Solid-state bonding of the Mo–0.5% Ti alloy and unalloyed Mo and W using a vacuum-hot-pressing technique was investigated. Unalloyed interface metals (0.001 in. foil) were used to obtain activated-diffusion at temperatures below the recrystallization temperatures of the base–metals. A surface conditioning treatment (cold-grinding) of the base–metal substrates was used to enhance diffusivity and to improve bonding characteristics. Various bonding pressures were evaluated to establish a minimum practical pressure range with which completeness of bond could be obtained. Bonding temperatures were established for each diffusion system using a minimum temperature (below 1850°F)–minimum time-at-temperature (20 minutes) criterion. Bonding parameters were established for the Mo–0.5 Ti–Ni, Mo–0.5 Ti–Ti, W–Ni, W–Ti, and W–Nb diffusion systems (couples). A W–Ni–Nb–W diffusion composite was also investigated. Diffusion couples involving Mo–0.5 Ti alloy substrates were evaluated in the as-bonded and the as-bonded plus post-bond diffusion treated (30, 54, and 78 hours at 2050°F) conditions. The diffusion systems involving tungsten substrates were evaluated in the as-bonded and the as-bonded plus post-bond diffusion treated (24 and 48 hours at 2100°F) conditions. Recrystallization of the base-metal substrates did not occur in any of the systems in the as-bonded condition. The W–Ti and W–Nb couples were the only systems which did not exhibit recrystallization and grain growth after post-bond thermal treatment (even after 48 hours at 2100°F). Grain boundary diffusion was apparent only in the Mo–0.5 Ti–Ti couple after post-bond treatment. The brittle nature of the intermediate phases was revealed by the occurrence of thermal (cooling) cracks normal to the direction of translation of the intermediate phase fronts. (auth)

9124 JOINING OF TUNGSTEN SHEET. Hickox, G. K.; Hoffman, E. L.; Handley, R. E. (Aerojet-General Corp., Sacramento, Calif.). Met. Soc. Conf., 30: 411-20(1966).

Arc-welding, electron-beam welding, and diffusion brazing have been investigated as methods of joining W for application to the fabrication of solid rocket nozzles and nozzle accessories. These studies indicate that arc welding with either the TIG process or MIG process involves mechanical and metallurgical problems that render these methods less than satisfactory. Electron-beam welding is more suitable for welding this material since the process eliminates some of the mechanical and metallurgical problems. Diffusion brazing is a process whereby the tungsten is joined by a brazing operation and the brazed joint is then modified by solid state diffusion mechanisms to improve the joint properties. Joints made at 2550°F have shown consistent high temperature remelt properties. (auth)

9125 SPINNING OF REFRACTORY METALS. Straub, C.; Haily, R. W. (Super Metals Co., Sante Fe Springs, Calif.). Met. Soc. Conf., 30: 423-31(1966).

General procedures for fabrication of refractory metals, chiefly W, by spinning are described, together with illustrations of practice for typical parts. (auth)

9126 FABRICATION OF SOLID-ROCKET NOZZLES BY SHEAR AND CONVENTIONAL SPINNING OF TUNGSTEN PLATE. Banta, F. L.; Heimlich, C. W.; Bystra, N. J. (Aerojet-General Corp., Sacramento, Calif.). Met. Soc. Conf., 30: 437-49(1966).

Extensive process and metallurgical evaluations were conducted to establish fabrication-process parameters for conventional-spinning W plate 0.250-in. or thicker. Variations in the primary processing parameters were also evaluated, to determine effects on the fabricability of unalloyed W plate. (auth)

9127 MACHINABILITY OF HIGH DENSITY UNALLOYED TUNGSTEN AND SILVER-INFILTRATED TUNGSTEN. Arzt, P. R.; Stewart, I. J. (Aerojet-General Corp., Sacramento, Calif.). Met. Soc. Conf., 30: 469-82(1966).

The machining characteristics of high density (forged), unalloyed W and Ag-unfiltrated W were investigated in laboratory turning tests. The influence of machining parameters on tool life, tool forces, and part surface finish were determined and compared. From these tests, producibility criteria were determined and recommendations were developed for the turning of both unalloyed and silver-infiltrated tungsten. (auth)

9128 MACHINING REFRACTORY METALS. Zlatin, N. (Metcut Research Associates, Cincinnati); Field, M.; Gould, J.; Jameson, R. T. Met. Soc. Conf., 30: 483-96(1966).

The machining characteristics of four representative refractory materials (W, D-31, TZM, and Ta–W) are described. Charts are presented comparing these metals with other aerospace alloys with respect to tool life and cutting speeds. (auth)

9129 CHEMICAL BLANKING AND VIBRATORY RADIUSING OF MOLYBDENUM ALLOYS. Roni, J. C. (Boeing Co., Seattle). Met. Soc. Conf., 30: 497-505(1966).

Processes of chemical blanking and vibratory radiusing developed to produce complex close tolerance parts from Mo alloy sheet stock are described. Chemical blanking, which involves the use of a chemical etchant, is used to mill configurated parts from alloys whose mechanical properties make conventional blanking or cutting difficult. Vibratory radiusing equipment reduces deburring time, the danger of part deformation during edge finishing, and improves the edge condition of small, delicate parts of alloys. (P.C.H.)

9130 TUNGSTEN CLADDING OF REACTOR FUELS. Lindgren, J. (General Atomic Div., General Dynamics Corp., San Diego, Calif.); Weinberg, A.; Elsner, N.; Holzl, R. Met. Soc. Conf., 30: 585-96(1966).

Methods for W cladding of reactor fuels by vapor deposition and diffusion bonding are described. The fuels coated were UC, UC–ZrC, W–UC, and W–UO_2 cermets. Metallographic examination of several of the specimens after fabrication and out-gassing showed that there was little, if any, evidence of reaction or attack on the carbide in all the specimens examined. (P.C.H.)

9131 FABRICATION OF REFRACTORY METAL NUCLEAR THERMIONIC EMITTER THIMBLES. Holden, A. N. (General Electric Co., Pleasanton, Calif.). Met. Soc. Conf., 30: 609-21 (1966).

Methods for producing nuclear thermionic emitter thimbles by machining, vapor deposition, welding, and mechanical working are discussed. The quality of these thimbles, and the problems associated with fabricating them are described. The welding of W emitters by inert-gas arc welding is shown to be practical though difficult, and the successful operation of a welded nuclear thermionic diode emitter is described. (auth)

9132 THE FABRICATION OF A LARGE NIOBIUM–1 PERCENT ZIRCONIUM PUMPED LOOP FOR BOILING-POTASSIUM SERVICE. Franco-Ferreira, E. A. (Oak Ridge National Lab., Tenn.). Met. Soc. Conf., 30: 623-31(1966).

The fabrication of the first of a series of large refractory-metal loops, in particular a Nb–1% Zr pumped loop for boiling-K service, is described. The loop is currently performing satisfactorily under design conditions and is approaching scheduled termination. (P.C.H.)

9133 FABRICATION OF A Nb ALLOY LIQUID METAL LOOP. Kearns, W. H.; Redden, T. K.; Young, W. R. (General Electric Co., Evendale, Ohio). Met. Soc. Conf., 30: 633-47(1966).

Fabrication procedures for producing a Nb alloy liquid–metal loop are described. Such a loop has been operating successfully for a long time in boiling Na and K. (auth)

9134 FABRICATION OF REFRACTORY METAL HONEYCOMB STRUCTURES. Schwartz, Mel M. (Martin Co., Baltimore). Met. Soc. Conf., 30: 973-85(1966).

Fabrication technology for construction of heat shield panels of D-36 Nb alloys is described. Some difficulties were encountered in fabrication of similar panels of TZM Mo alloy. (auth)

Properties Evaluations

Refer also to abstracts 8259, 9069, 9088, 9098, 9103, 9109, 9110, 9113, 9197, and 9519.

9135 (AD-638631) THE MECHANICAL AND THERMAL PROPERTIES OF TUNGSTEN AND TZM SHEET PRODUCED IN THE REFRACTORY METAL SHEET ROLLING PROGRAM. PART I. (Southern Research Inst., Birmingham, Ala.). Aug. 31, 1966. Contract N600(19)-59530. 200p. CFSTI $3.00 cy, $0.65 mn.

An evaluation program was performed to obtain preliminary design data for W and TZM sheet. W sheet 0.060- and 0.10-in. thick, and TZM sheet 0.020-, 0.040-, and 0.060-in. thick, were investigated. Both materials were studied in the optimum (warm worked and stress relieved) and recrystallized conditions. Mechanical properties evaluated included tensile, notched-tensile, compression, bearing, shear, creep, thermal-stability, and weld joint efficiency. The recrystallization and bend-transition temperatures were also determined. Physical properties that were evaluated included density, thermal expansion, thermal conductivity, and specific heat. Tensile and bend evaluations were performed on the TZM sheet after application of two commercial coatings. (TAB)

9136 (AECL-2605) THE EFFECT OF FIBRE ORIENTATION ON THE TENSILE STRENGTH OF HOT-PRESSED ALUMINUM-INCONEL AND ALUMINUM-TUNGSTEN COMPOSITES. Childs, B. G. (Atomic Energy of Canada Ltd., Chalk River (Ontario)). Sept. 1966. 36p. Dep. mn. AECL $1.00.

Composites of Inconel or W fibers in a matrix of 56 S Al alloy were produced by pressing mixed bundles of 0.004 in. dia wires at 500°C. The tensile strength at 20°C of the composites, and of the unreinforced matrix, was measured as a function of the wire orientation relative to the stress direction. The strength was found to decrease more rapidly with orientation than expected. This behavior apparently results from the presence of oxide interfaces in the specimens which are relatively weak in tension and shear. Values were obtained for the tensile and shear strengths of the interfaces in the specimens. (auth)

9137 (GEMP-61, pp 17-32) HIGH-TEMPERATURE REACTOR MATERIALS RESEARCH. Conway, J. B.; Flagella, P. N. (General Electric Co., Cincinnati, Ohio. Nuclear Materials and Propulsion Operation).

Creep-rupture tests were made on Mo-Re-W alloys and on arc-cast Mo and W sheets. Effect of alloy composition on ductility and creep resistance at 1600 and 2200°C for various stress levels was determined. (P.G.C.)

9138 (GEMP-61, pp 133-42) EVALUATIONS OF THE PLASTIC FATIGUE PROPERTIES OF HEAT-RESISTANT ALLOYS. Moteff, J.; Slot, T. (General Electric Co., Cincinnati, Ohio. Nuclear Materials and Propulsion Operation).

Equipment and techniques for making low-cycle fatigue tests of stainless steels are described and results of tests made on 31 specimens of type 304 are shown. (P.G.C.)

9139 (GEMP-61, pp 171-6) HIGH-TEMPERATURE THERMOCOUPLE AND ELECTRICAL MATERIALS RESEARCH. Funston, E. S.; Kuhlman, W. C. (General Electric Co., Cincinnati, Ohio. Nuclear Materials and Propulsion Operation).

The thermoelectric properties of Mo-49 at. % Ru were investigated in the development of high-temperature thermocouples, electrical, and electronic materials for high-temperature reactors. Sensitivity of the Mo-Ru alloy, when used with a positive thermoelement of Mo-1 at. % Ru, is 6.3 microvolts °C at 1400°C. Thermoelectric output signal of a W-5 Re/W-25 wt % Re thermocouple decreased because of nuclear transmutations after 6 months exposure to thermal neutron flux, causing the true temperature to be higher than the temperature predicted from the calibration curve for an unirradiated W-5 Re/W-25 Re thermocouple. (P.G.C.)

9140 (KAPL-M-6574) PRELIMINARY STUDY OF NIOBIUM-SILICON ALLOYS. Calhoun, C. D. (Knolls Atomic Power Lab., Schenectady, N. Y.). Jan. 1966. Contract W-31-109-eng-52. 18p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Preliminary studies were made on the mechanical properties of Nb-Si alloys of 0.05, 0.1, 0.2, 0.25, and 0.5 wt. % Si. Hardness data at 25 to 900°C, tensile properties at 25 to 790°C, and the microstructure as influenced by fabrication and heat treatments were investigated. (auth)

9141 (MCW-1505) MECHANICAL PROPERTIES OF DILUTE URANIUM ALLOYS AT ELEVATED TEMPERATURES. Nolan, M. F. (Mallinckrodt Chemical Works, Weldon Spring, Mo. Uranium Div.). Aug. 1, 1966. Contract W-14-108-eng-8. 64p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

High temperature tensile tests and prolonged hot hardness tests of U alloys were conducted for correlation of results with in-reactor behavior. Tensile test techniques are discussed for one alloy tested at 25°C and between 100 and 600°C at 100° intervals. The mechanism of flow and fracture is discussed in terms of temperature structure, strain, and strain rate. Activation energy values for plastic flow are presented. Hot hardness tests at 400°C under a 600 pound load applied for 22 hours are described for both spring-loaded and level-loaded equipment. The data indicated that the dia of indentation decreased as the alloy content of the U increased. The resistance to indentation, however, appeared to be a function of the degree of solid solution hardening and not of the total alloy content. A sensitive response to thermal history therefore seemed likely. A correlation with resistance to in-reactor swelling was not obtained. (auth)

9142 (N-66-28010) DIMPLE, SPALL, AND PERFORATION CHARACTERISTICS IN ALUMINUM, COLUMBIUM, AND STEEL PLATES UNDER HYPERVELOCITY IMPACT. Clough, Nestor; McMillan, A. R.; Lieblein, Seymour (National Aeronautics and Space Administration, Cleveland, Ohio. Lewis Research Center). June 1966. 21p. (NASA-TN-D-3468). CFSTI $3.00 cy, $0.65 mn.

An experimental research program designed to determine the critical damage modes that might be inflicted on various materials by the impact of a high-velocity projectile was conducted. Spherical pyrex projectiles of nominally 2.38- and 3.18-mm dia were accelerated to velocities of approximately 7.6 km/sec and impacted against flat-plate targets at room temperature in an evacuated impact chamber. Target thickness at incipient perforation, rear-surface dimple, and spall were determined for plates of AISI 316 stainless steel, 2024-T6 Al, and Nb-1% Zr. The results indicated that the thickness at the onset of each of these damage modes varied significantly with each material. Nb-1% Zr showed thicknesses at incipient dimple and spall substantially greater than those for Al and stainless steel. The materials coefficient used to correlate crater depth with the modulus of elasticity of the material was also determined. A wide variation in the value of the materials coefficient was found for the three materials impacted. (STAR)

9143 (NP-16411(Vol.4)) MATERIAL PROPERTIES HANDBOOK. VOLUME IV. HEAT RESISTING ALLOYS. (Advisory Group for Aerospace Research and Development, Paris (France)). May 1966. 261p. CFSTI $3.00 cy, $0.65 mn.

Data in tabular form are presented on the physical and mechanical properties of the aircraft materials produced by NATO nations. The materials covered in this volume are heat-resisting alloys of Fe, Ni, and Co base, and the data are divided into national sections (French, German, United Kingdom, and United States). (D.L.C.)

9144 (RFP-658, pp 160-7) MICROHARDNESS OF PLUTONIUM-GALLIUM ALLOYS. Hays, D. D. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

The effects of surface preparation, indenting load, and Ga content on the microhardness of fully homogenized Pu-0.78, 0.99 and 1.27 wt % Ga alloys were determined. (auth)

9145 DEVELOPMENT OF HIGH TOUGHNESS IN UNALLOYED MOLYBDENUM. Barr, R. Q.; Chesmar, G. G.; Semchysen, M. (Climax Molybdenum Co., Detroit). Met. Soc. Conf., 30: 17-26 (1966).

Studies were made to develop a type of unalloyed Mo which would exhibit lower brittle-to-ductile transition temperatures than available heretofore in wrought shapes of Mo. Composition, particularly the interstitial contents, and mechanical working parameters were evaluated. Special attention was given to the influence of carbon content. (auth)

9146 PRODUCTION OF UNALLOYED MOLYBDENUM FORGINGS FOR SERVICE REQUIRING HIGH IMPACT STRENGTH. Roshong, R. L.; Leeper, W. A. (Cameron Iron Works, Inc., Houston, Tex.). Met. Soc. Conf., 30: 27-36(1966).

The development of forging stock with low interstitial content and forging practice to develop a high, uniform degree of work permitted high toughness in Mo rings and other parts with circular cross section for rocket nozzles and hardware. (auth)

9147 SHAPE ROLLING OF REFRACTORY METALS. Bianchi, L. M. (Universal-Cyclops Steel Corp., Bridgeville, Pa.). Met. Soc. Conf., 30: 49-56(1966).

The general properties of metals that affect their ability to be shape rolled are discussed. The effects of lubrication, pass design, and temperature on the reductions that can be taken are included. The effects of lubrication, percent reduction, temperature, and angle of incident on the surface finish obtained are also discussed. The rolling of a shape in Mo and Nb is described, along with shape rolling characteristics of the shapes. Surface finish and cross section uniformity of properties are emphasized. (P.C.H.)

9148 PERMEABILITY OF SINTERED TUNGSTEN. Kinney, G. F. (Naval Postgraduate School, Monterey, Calif.); Conabee, E. E.; Cronin, L. J. Met. Soc. Conf., 30: 295-306(1966).

The relations between permeability, void volume, and particle size in porous sintered W are described. For original particle sizes ranging from 1 to 60 μ, and for densities of sinter ranging from 60 to 85% of theoretical density, the permeability varied as fourth power of the fractional void volume and as the three halves power of the nominal particle size in the original powder. From these data, it becomes possible to prepare sintered W to a specified permeability and to anticipate items such as the pressure drop required to produce a specified rate of flow for a fluid through this sintered material. (P.C.H.)

9149 STRUCTURAL DEFECTS IN INFILTRATED TUNGSTEN MATRICES. Matt, R. E. (Aerojet-General Corp., Sacremento, Calif.). Met. Soc. Conf., 30: 307-13(1966).

Infiltrated W is a composite material in which the W matrix density is controlled between 75 and 83% of theoretical, and in which the Ag fills at least 90% of the available pore spaces. The tensile strength of the composite is a function of the matrix and is relatively consistent for good-quality material. It was found that internal defects such as voids, oxides, and high-density areas disrupt the structural uniformity of the composite and adversely affect the tensile strength. (auth)

9150 DUCTILITY OF DISSIMILAR REFRACTORY METAL WELDS. Coughlin, S. A. (Babcock and Wilcox Co., Alliance, Ohio). Met. Soc. Conf., 30: 353-77(1966).

Dissimilar combinations of refractory metals with other metals were accomplished by arc welding when restraint was not severe. For rigid weldments, refractory metals with high ductile-to-brittle transition temperatures required special precautions to avoid cracking. (auth)

9151 TENSILE PROPERTIES OF SHEAR-SPUN TUNGSTEN UP TO 6000 DEG F. Dotson, C. L. (Southern Research Inst., Birmingham, Ala.); Rogers, O. V.; Banta, F. L. Met. Soc. Conf., 30: 451-68(1966).

Tensile evaluations at 70 to 6000°F were conducted on rocket-nozzle preforms shear spun to 50 and 75% reductions from 1/4-in. W plate produced by two domestic suppliers and one European supplier. Results showed that the higher strength (160-200 ksi) of the 75%-reduced material at 70°F rapidly decreased and approached that of the 50%-reduced W between 900 and 2400°F. Although differences in the low-temperature strength of the three materials were observed, the tensile strength of all preforms was comparable at high temperatures, decreasing from about 45 ksi at 2400°F to 3 ksi at 5000°F. The tensile properties of the shear-spun preforms were generally higher than those of 1/4-in. W plate up to 3000°F and higher than those of W sheet up to about 1000°F. (auth)

9152 DIFFUSION BARRIERS FOR USE IN PROTECTIVE COATING SYSTEMS FOR TUNGSTEN AND MOLYBDENUM. Passmore, E. M. (Avco Corp., Wilmington, Mass.); Boyd, J. E.; Lement, B. S. Met. Soc. Conf., 30: 681-92(1966).

Nineteen combinations of potential barrier metals with W and Mo base metals were subjected to evaluation tests comprising diffusion-annealing treatments at 1700 and 1800°C. Further evaluation was based on studies of barrier-coating and base-barrier-coating interdiffusion, measured by microhardness and metallographic techniques. Using such factors as interdiffusion zone thickness, interfacial hardness, and barrier oxidation resistance as criteria, the following combinations were found to be the most promising: W–Re, W–Ru, and W–Ir with W as base metal; and Mo–W and Mo–Re with Mo as base metal. (auth)

9153 EFFECT OF W-3 OXIDATION-RESISTANT COATING ON THE MECHANICAL PROPERTIES OF NOTCHED AND UNNOTCHED TZM SHEET. Raiklen, H. I.; Rubino, R. V. (Republic Aviation Corp., Farmingdale, Calif.). Met. Soc. Conf., 30: 719-36(1966).

The oxidation-resistant coating W-3, which is a proprietary coating, was applied to TZM sheet by pack cementation methods. Deterioration of the mechanical properties of the TZM sheets was noted but not to the extent that utility was lost. (P.C.H.)

9154 THERMAL CRACKING IN REFRACTORY METAL THROATS OF SOLID ROCKET NOZZLES. Kahle, V. E.; Onoda, G. Y. Jr. (Aerojet-General Corp., Sacremento, Calif.). Met. Soc. Conf., 30: 843-55(1966).

Characteristic features associated with longitudinal-circumferential cracking of refractory-metal inserts in solid-rocket motors are described. Stresses arising in the insert during the early seconds of firing and the effects of material quality on the strength level necessary to resist these stresses are discussed. (auth)

9155 THERMAL SHOCK FAILURE OF TUNGSTEN. Gordon, G. M.; Brown, D. A. (Stanford Research Inst., Palo Alto, Calif.). Met. Soc. Conf., 30: 857-70(1966).

A method of simulating thermal shock failure of W in the laboratory is described. Ag- and Cu-infiltrated W were found to have the best thermal shock resistance of the material studied. (auth)

9156 CREEP PROPERTIES OF Nb ALLOYS IN VERY HIGH VACUUM. Hall, R. W.; Titran, R. H. (Lewis Research Center, Cleveland). Met. Soc. Conf., 30: 885-900(1966).

The results of creep studies on Nb alloys at elevated temperature under very high vacuum are described. Tests (300 hr) conducted on 0.030 in. thick recrystallized sheet specimens at a stress of 4000 psi and at temperatures of 2000, 2200, and 2400°F indicated that the alloys FS-85 and D-43 have superior creep strength under these conditions. The alloys B-66 and Cb-752 were not so creep resistant but appeared worthy of more thorough evaluation. (P.C.H.)

9157 METALLURGY OF MOLYBDENUM AT 4000 DEG F. Flagella, P. N. (General Electric Co., Evendale, Ohio). Met. Soc. Conf., 30: 917-25(1966).

The mechanical properties of Mo were studied at 4000°F in H and Ar atmospheres. The metallurgical condition of the materials after completion of the tests is described. (auth)

9158 MEASUREMENT OF INFILTRANT LOSS FROM INFILTRATED REFRACTORY METAL COMPOSITES AT HIGH TEMPERATURES. Kotfila, R. J. (Aerojet-General Corp., Sacremento, Calif.); Myers, C. L. Jr. Met. Soc. Conf., 30: 927-33(1966).

Infiltrated W is being used for nozzle inserts because of potential cooling that may be obtained. Four distinct infiltrant loss mechanisms operate during a firing cycle which will cause loss of the Ag infiltrant from the W matrix. The nature of these mechanisms are discussed and an experimental approach for the measurement of infiltrant loss due to each mechanism is described. (auth)

9159 AN APPLICATION OF REFRACTORY METALS TO AN INSTRUMENTATION PROBLEM. Howland, W. L.; Keys, G. T. (Lockheed-California Co., Burbank). Met. Soc. Conf., 30: 949-60(1966).

Instrumentation largely constructed of refractory metals is described for making strain measurements at high temperatures. The method could also be used for strain measurements in spacecraft structures. (auth)

9160 FLAME TEMPERATURE MEASUREMENT USING W/W–26 PERCENT Re THERMOCOUPLES TO CORRECT OPTICAL PYROMETER READINGS. Manson, D. J.; Delaney, R. M.; Weber, A. H. (St. Louis Univ., Mo.). Met. Soc. Conf., 30: 961-72 (1966).

The measurement of temperatures in flames is complicated by heat radiation and conduction by the measuring instrument. A method using the response time of W/W-26% Re thermocouples to calculate a correction for radiation errors in optical pyrometer readings is presented. Results were compared with spectroscopic measurements in similar flames. (auth)

9161 REFRACTORY MATERIALS IN THERMIONIC CONVERTERS FOR SPACE APPLICATIONS. Bernett, E. C. (California Inst. of Tech., Pasadena). Met. Soc. Conf., 30: 987-96 (1966).

Problems involved in the use of refractory materials in thermionic convertors for spacecraft use are discussed. Ta emitters operating at high temperatures showed pronounced grain growth and intergranular cracking. Grain boundary attack by Cs was also observed. Brazing was used extensively for joining various components. Embrittlement of Nb and Mo near the braze joint was often found. However, the potential of thermionic converters for space applications has been adequately demonstrated by the experimental diodes produced thus far. (P.C.H.)

9162 EFFECT OF THE GAS CONTENT ON THE SUSCEPTIBILITY OF Ti–Al–Zr WELDS TO DELAYED FAILURE AND COLD CRACKING. Meshcheryakov, V. N.; Shorshorov, M. Kh.; Florinskii, Yu. B. (Baikov Inst. of Metallurgy, USSR). Svarochn. Proizv., No. 11, 11-12(1966). (In Russian).

The susceptibility to delayed cold cracking in the heat-affected zone of the welds in α–Ti alloys of the Ti–Al–Zr system containing from 0.13 to 14 and 0.45% O_2 and from 0.002 to 0.15% H_2 was investigated. Notched specimens with a TIG spot weld on each side of the notch were subjected to a prolonged tensile test under a constant stress and the plastic deformation was measured during the test as well as after rupture. Results showed that increasing the oxygen content from 0.14 to 0.45% in a Ti–Al–Zr alloy at a low hydrogen content of 0.002% increased the rupture strength of both the base and the heat-affected zone metal from 68 to 69 and 80 to 84 kg/mm^2, and the time-to-rupture from 0.25 to 5 and 4 to 7 days. The reduction of area at rupture decreased only from 15 to 20% and 9 to 8%, which indicated that both the base and the heat-

affected zone metals remain capable of plastic deformation and, consequently, stress relaxation. The insignificant increase in sensitivity to delayed cold cracking with increasing oxygen content is ascribed to a favorable effect of Zr, which forms a compound with O_2, or reduces the effectiveness of dislocation pinning by O atoms. Increasing the hydrogen content of alloys from 0.002 to 0.015% decreased the rupture strength of the base metal containing 0.1 and 0.29% O_2 by only 2 to 2.5 and 3.5 to 4 kg/mm², respectively. The metal in the heat-affected zone had a somewhat higher resistance to delayed cold cracking than the base metal, probably because of partial desorption of hydrogen in welding. (ATD)

9163 DIFFUSION OF URANIUM IN MOLYBDENUM, NIOBIUM, ZIRCONIUM, AND TITANIUM. Pavlinov, L. V.; Nakonechnikov, A. I.; Bykov, V. N. J. Nucl. Energy: Pt. A and B, 20: 1027-30(Nov.-Dec. 1966).

An investigation was made of the diffusion of uranium in molybdenum, niobium, zirconium, and titanium. The diffusion coefficients were established by measuring the integral activity of the residue of the sample, using the α-radiation of uranium enriched up to 90% with ^{235}U, at temperatures of 1500 to 2000°C (for molybdenum and niobium) and 915 to 1200°C (for zirconium and titanium). Values are presented for the temperature dependence of the diffusion coefficients. The substantial differences between the diffusion mobility and activation energy values of molybdenum and niobium on the one hand and zirconium and titanium on the other are probably due to defects in the crystal lattice, such as excess vacancies in zirconium and titanium due to polymorphic transformation. (tr-auth)

9164 EFFECTS OF SOME ADDITIONAL ELEMENTS ON THE DUCTILITY OF ELECTRON BEAM MELTED MOLYBDENUM INGOTS. Tsuya, Kazuo; Aritomi, Noriyoshi (National Research Inst. for Metals, Tokyo). Nippon Kinzoku Gakkai, 30: 952-8(1966). (In Japanese).

Molybdenum ingots, which are electron-beam melted without any additions, are not ductile at room temperature and liable to intergranular fracture under a low stress. An investigation of the variations in ductility of some kinds of molybdenum ingots electron-beam melted with C, B, Zr, and Ti, respectively and a study of the mechanisms for the improvement of their ductility by melting with the additional elements were made. Bend tests, measurements of intergranular fracture stresses, and observations of fracture surfaces were made. The ductility of molybdenum ingots at room temperature was improved by electron beam melting with the optimum amounts of C, B, and Ti, respectively. However, the addition of Zr did not improve the ductility of ingots. Improvement in ductility was dependent on the strengthening of grain boundaries. Judging from fractographic observations, it was considered that in the cases of C and B additions, the intergranular fracture strength was increased by the suitable amounts of intergranular precipitates. In the case of Ti addition, it was assumed that grain boundaries were strengthened by eliminating the segregation of some harmful impurities at grain boundaries. The degree of improvement in ductility of molybdenum ingots by additional elements depended on the two opposite effects of the added elements, i.e., the lowering of ductility of matrix and the strengthening of grain boundary. (auth)

9165 HIGH-TEMPERATURE MOBILITY OF ATOMS OF MOLYBDENUM–TUNGSTEN SYSTEM COMPONENTS. Kalinovich, D. F.; Kovenskii, I. i.; Smolin, M. D. Porosh. Met., Akad. Nauk Ukr. SSR, No. 11, 57-61(Nov. 1966). (In Russian).

The diffusion of both components was investigated in a molybdenum-tungsten system at concentrations of the latter metal of 0.1, 15, 20, 25, 35, 50, 65, 70, 80, 85, and 99.9 at. %. The temperature range of the experiments, carried out with the help of tracers ^{99}Mo and ^{185}W, was 600 to 1000°C. The values of D_0 and E were calculated for all investigated alloys. (auth)

9166 SENSITIZATION AND THERMAL STABILIZATION OF Ni–Cr–Mo–Fe–W ALLOY. Samans, C. H. (Texaco, Inc., Port Arthur, Tex.); Meyer, A. R.; Tisinai, G. F. Corrosion, 22: 336-45(Dec. 1966).

The formation of a precipitate, isomorphous with $(Fe,Co)_7(Mo,W)_6$ and relatively rich in tungsten, has been studied in 38 plates, $^1/_{16}$ to $^{15}/_{16}$ in. thick, made from 24 commercial heats of Ni–Cr–Mo–Fe–W alloy. Heating temperature, holding time at temperature, rate of heating, and rate of cooling affect precipitation. If cooling to below 1050°F (565°C) takes less than 2 minutes, precipitation is determined solely by the heating cycle. No visible precipitation occurs above 2100°F (1150°C). Precipitated particles form a complete grain-boundary envelope in the range 1600°F (870°C) to 1975°F (1080°C). Numerous particles precipitate within the grains in the range 1500°F (815°C) to 1600°F (870°C). From 1250°F (675°C) to 1500°F (815°C) the grain boundary precipitate is much finer but resolvable, with accompanying optical effects and from 1075°F (580°C) to 1250°F (675°C) the precipitate is unresolvable. Rapid cooling from above 2235°F (1225°C) to suppress precipitation gives best corrosion resistance, but treatment is impractical for large process vessels because of the required heat removal rate and the accompanying distortion. A dependable microstructure with a thermally stabilized precipitate can be secured, even in the thicker sections, by heating slowly to 2140 ± 20°F (1170 ± 10°C) and holding 1 hr, furnace cooling to 2025°F (1105°C) and holding a minimum of 2 hr and then cooling to below 1050°F (565°C) in less than 30 minutes. A single-pass weld does not sensitize material so treated, but subsequent passes will. Treatment increases tensile strength markedly but has little effect on yield strength and reduces ductility and notch toughness significantly; these effects are more pronounced in wrought than in weld metal. Although weld metal does not meet all ASME Code requirements, welded pressure vessels given the heat treatment have operated successfully for five years. (auth)

9167 SOME PROPERTIES OF PROTACTINIUM METAL. Cunningham, B. B. (Univ. of California, Berkeley). pp 45-8 of Physico-Chimie du Protactinium. Paris, Centre National de la Recherche Scientifique, 1966.

Protactinium metal was prepared on the milligram scale by the barium reduction of PaF_4. Well-fused pieces of metal resulted from reductions carried out in tungsten baskets at 1,300°C. The soft metal was cleaned by scraping and then used for various physico–chemical measurements. In agreement with the earlier work of Zachariasen a body-centered-tetragonal structure was seen for protactinium metal. The observed lattice parameters at room temperature were a = 3.929 ± 0.001 and c = 3.241 ± 0.002 Å. A sample of metal, cooled in a few seconds from 1,580°C to room temperature, did not exhibit the tetragonal structure observed in unquenched samples but this different structure was not interpreted. The magnetic susceptibility of protactinium metal was investigated from room temperature to 20°K. The molar susceptibility was found to be $(270 \pm 50) \times 10^{-6}$ cgs units at room temperature and to be virtually independent of temperature over the temperature region investigated. This magnetic behavior is thus similar to that of tantalum. The melting point of protactinium metal was determined to be 1560 ± 20°C. An initial rapid reaction took place when Pa metal was treated with 6M HCl but the reaction quickly ceased with little of the protactinium dissolved. Treatment with HF reinitiated reaction but this too quickly stopped. Evidently there is formed on Pa metal a protective coating, which resists dissolution even by hydrofluoric acid. (auth)

9168 SINTERED, POROUS METALLIC ELEMENTS: THEIR PROPERTIES AND APPLICATIONS. Meyer, R.; Potet, P.; Pillot, J. (Laboratoire de la Societe Ugine-Carbone, Grenoble, France). Chim. Ind. (Paris), 96: 317-32(Aug. 1966). (In French).

Theoretical and practical aspects of sintering technics employed with numerous metals and alloys to provide porous materials with high corrosion resistance, particularly for nuclear industrial purposes are considered. Methods used to test these products are described. Nuclear technology applications and materials include closed-circuit tubes for heavy water, demineralized light water, Na, K, terphenyl, and CO_2; filters for gaseous or fluid effluents to collect radioactive particles; filters for processing nuclear fuel and solid precipitates of radionuclides; and fine filters for exhausts of gas-phase reactors. Such materials and their processing are described and illustrated. Reliability testing is considered, as well as some characteristics of stainless steel and bronze products, in particular. Special properties of sintered porous elements for specific uses are examined. (BBB)

9169 ACOUSTIC RELAXATIONS IN ZIRCONIUM–NIOBIUM ALLOYS. Nelson, C. W.; Gibbons, D. F.; Hehemann, R. F. (Case Inst. of Tech., Cleveland). J. Appl. Phys., 37: 4677-82 (Dec. 1966). (COO-588-11).

Acoustic measurements are reported which were made by the composite resonator technique on polycrystalline and single-crystal specimens of Zr–Nb alloys (0%–25% Nb). Three distinct thermally activated relaxation peaks were observed. In the frequency range 80 to 800 kc, the relaxations occur in the neighborhood of 160, 40, and 12°K, with activation energies of 0.3, 0.05, and ~0.02 eV, respectively. The relaxation which occurs at 12°K has only been observed in Zr–5% Nb. The 160 and 40°K relaxations were demonstrated to be associated with the $\beta \rightarrow \omega$, athermal transformation. An atomic model for the 160°K relaxation process is presented and a tentative suggestion made for the origin of the relaxation at 40°K. No mechanism for the 12°K relaxation is attempted. (auth)

9170 THE SPECIFIC HEAT FROM 50 TO 700 DEG C OF A NOMINAL Ni (16 WT. PERCENT Mo, 7 WT. PERCENT Cr, 5 WT.

PERCENT Fe) ALLOY. Brooks, C. R.; Stansbury, E. E. (Univ. of Tennessee, Knoxville). J. Nucl. Mater., 20: 332-3(Sept. 1966). (ORO-3291-4).

Results of the determination by dynamic adiabatic calorimetry of the specific heat of a Ni-base alloy containing 16 wt % Mo, 7 wt % Cr, and 5 wt % Fe are presented. An anomalous rise in the specific heat starting at 550°C is qualitatively similar to that observed in Ni-Cr and Ni-Mo solid solution alloys but larger in magnitude. The anomaly may be tentatively rationalized on the basis that near 550°C the rate of dispersion of short-range order is sufficient to produce a measurable increase in heat absorption. (A.G.W.)

9171 TEMPERATURE-INDEPENDENT ELASTIC MODULUS IN DEFORMED NIOBIUM-ZIRCONIUM ALLOYS. Albert, H.; Assmus, F.; Pfeiffer, I. (Vacuumschmelze GmbH, Hanau, Ger.). Solid State Commun., 4: 519-20(Oct. 1966). (In German).

A region of anomalous temperature dependence and vanishing temperature coefficient of Young's modulus is found in severely cold-worked and heat-treated Nb alloys with 19 to 33 wt % Zr. The variations of temperature coefficient are caused by decomposition of the β phase. (auth)

9172 THE WIEDEMANN-FRANZ RATIO OF METALLIC URANIUM AT ELEVATED TEMPERATURES. Erez, Gidon; Even, Uzy (Nuclear Research Center, Tel-Aviv, Israel). J. Appl. Phys., 37: 4633-4(Dec. 1966).

The electric resistivity, heat capacity, and temperature diffusivity of U at 50 to 800°C were measured on the same sample. The Wiedemann-Franz ratio was then calculated. A transition seems to occur at 250°C. (auth)

9173 COMMENT ON DIFFUSION CREEP DEFORMATION IN A MAGNESIUM REACTOR COMPONENT. Raraty, L. E. (United Kingdom Atomic Energy Authority, Springfields, Eng.). J. Nucl. Mater., 20: 344-8(Sept. 1966).

Possible explanations of zones denuded of Mn-rich precipitate in reactor-fuel-element supports made of Mg-0.7 wt % Mn alloy are considered. Comparison of calculated diffusion creep rates with experimental measurements of minimum creep rates as a function of stress indicates that the denuded zones were not entirely due to diffusion creep; the stress required to produce the denuded zones has to be high enough to produce instantaneous collapse of the support. It is concluded that if diffusion creep occurs in Mg-Mn alloys containing 0.55 to 1.5 wt % Mn, its magnitude is much less than expected from Harris and Jones' diffusion creep formula. (A.G.W.)

9174 NEW VANADIUM-COLUMBIUM ALLOYS RESIST HIGH AND LOW TEMPERATURES. Holtz, F. C. (IIT Research Inst., Chicago). Mater. Design Eng., 64: No. 7, 91-3(Dec. 1966).

Studies showed that because of their high strength, notch toughness, and excellent fabricability, a new series of V-Nb alloys looks promising for high temperature and cryogenic applications. For short-time high temperature uses, the alloys are superior to conventional and dispersion strengthened superalloys above roughly 1800°F, and stronger than Nb and Mo alloys up to about 2400°F. When silicide coated, the new alloys can resist repeated cycling in hot air environments without seriously affecting mechanical properties. At cryogenic temperatures, the alloys have strengths as high as 200,000 to 300,000 psi with considerable ductility and toughness. (P.C.H.)

9175 COMPRESSIVE BEHAVIOR OF NATURAL URANIUM WITH THE AID OF UPSETTING TESTS. Buehler, Hans; Wagener, Hans Wilfried (Technische Hochschule, Hanover). Z. Metallk., 57: 825-30(Nov. 1966). (In German).

Flow-stress curves of natural U were investigated in dependence on deformation speed and temperature. The work hardening coefficient m of the equation $\lg k_f = \lg k_{f\,I,II,III} + m_{I,II,III} \cdot \lg\varphi$ and the speed coefficient n of the equation $\lg k_f = \lg k_{f0} + m \cdot \lg\varphi$ were determined. Furthermore the speed coefficient n was described by the equations $\lg n'' = b'' \cdot \lg\Theta + \lg j''$. At room temperature the material was examined in both the annealed and the unannealed state. (auth)

9176 MAGNETIC HYSTERESIS OF HOLMIUM METAL AT 4.2 DEG K. Safrata, R. S.; Fisher, T. R.; Shelley, E. G. (Stanford Univ., Calif.). J. Appl. Phys., 37: 4869-72(Dec. 1966).

Hysteresis loops are presented for a specimen of polycrystalline Ho metal at 4.2°K. The curves differ significantly from those previously reported, but such differences are not unexpected between two different samples of polycrystalline metal. Most qualitative features of the curves follow simply from single-crystal magnetization curves if a random distribution of c axes is assumed. The unusual position of the initial magnetization curve outside the hysteresis loops can be explained by a condition of zero-field stability for both a ferromagnetic and an antiferromagnetic structure. (auth)

9177 THE SOLUBILITIES OF CARBON, TANTALUM, TUNGSTEN, AND RHENIUM IN LIQUID PLUTONIUM. Bowersox, D. F.; Leary, J. A. (Los Alamos Scientific Lab., N. Mex.). J. Nucl. Mater., 21: 219-24(Feb. 1967). (LA-DC-7904).

The solubilities of C, Ta, W, and Re in liquid Pu were measured individually from 700 to 950°C. At 750°C the mole fractions of the solutes were 0.0161, 0.000 850, 0.000 0720, and 0.0192, respectively. The solubilities increased to 0.0447, 0.003 52, 0.000 379, and 0.0405, respectively, at 950°C. The data for each element were fitted to an equation of the form $\log_{10} N_x = A - BT^{-1}$, where N_x is the solubility of the element X expressed as the mole fraction and T is the temperature in °K. (auth)

9178 SOLUBILITY OF NIOBIUM PRECIPITATES IN AUSTENITE IN THE CASE OF LOW-CARBON CONSTRUCTION STEELS AND CONTAINING VERY SMALL QUANTITIES OF NIOBIUM. Mandry, Pierre; Dornelas, Walter (Institut de Recherches de la Siderurgie, Saint-Germain-en-Laye, France. Centre de Recherches Metallurgiques, Paris). Compt. Rend., Ser. C. 263: 1118-21(Nov. 7, 1966). (In French).

The solubility of niobium carbonitride precipitates in austenite was studied by determination of the niobium content of the residues of electrolytic extraction obtained from rods annealed at different temperatures. From the x-ray studies, it appears that in this case the total quantity of niobium present in the different residues always corresponds to one and the same niobium carbonitride. The solubility product and its heat of dissolution in the austenite were calculated. (tr-auth)

9179 INVESTIGATION OF THE TECHNOLOGICAL CHARACTERISTICS OF W-Ni-Cu ALLOYS CONTAINING DISPERSIVE INCLUSIONS OF ZIRCONIUM DIOXIDE. Antsiferov, V. N.; Shafit, I. A. Porosh. Met., Akad. Nauk Ukr. SSR, No. 11, 43-5 (Nov, 1966). (In Russian).

It is determined that increase of nickel in an alloy from 0.01 to 0.4% increases the relative density of tungsten from 79.7 to 97.1%. Introduction of dispersive inclusions of ZrO_2 in W-Ni alloy increases the relative density to some extent, and maximum relative density is observed at 3% by mass of ZrO_2. Subsequent increase of the ZrO_2 content decreases the relative density. Introduction of copper decreases the density of sintered samples. (auth)

9180 UNFAMILIAR METALS. Gonser, B. W. (Battelle Memorial Inst., Columbus, Ohio). J. Mater., 1: 913-63(Dec. 1966).

Metallurgical properties and potentialities of the following are reviewed: alkali and alkaline earth metals, Mn, Tc, Re, Pt, Pd, Rh, Ir, Ru, Os, Ga, In, Tl, Bi, Cd, B, Si, Ge, As, Se, Te, Sc, Y, rare earth metals, Po, Fr, Ra, and the actinide metals. Areas in which information is especially lacking are pointed out. (82 references.) (A.G.W.)

9181 THERMODYNAMIC PROPERTIES OF GAMMA-PHASE URANIUM-ZIRCONIUM ALLOYS. Fedorov, G. B.; Smirnov, E. A. At. Energ. (USSR), 21: 189-92(Sept. 1966). (In Russian).

Corrosion resistance, dimensional stability, and certain physico-mechanical properties of uranium fuel were improved by zirconium alloying. Thermodynamic and diffusion properties of uranium-zirconium alloys were studied at temperatures above 750°C (the unlimited solubility point of these metals). (tr-auth)

9182 STUDIES ON TEMPERING CHARACTERISTIC OF A-302YB. Nagashima, Shinichi; Mori, Naomichi (Yawata Iron and Steel Co., Ltd., Japan). Tetsu To Hagane, 51: 2037-9(Oct. 1965). (In Japanese).

Studies were made of the tempering characteristics of the quenched and normalized A-302YB steel plates for reactor use (20 mm thick), by mechanical, structural, and other physico-metallurgical tests, to clarify the relationship between the mechanical properties and the structure. The chemical composition was: C, 0.18 ladle and 0.19 check; Si 0.21 and 0.21; Mn, 1.28 and 1.23; D, 0.009 and 0.010; S, 0.006 and 0.006; Cu, 0.09 and 0.072; Cr, 0.040 and 0.041; Mo, 0.55 and 0.56; Ni, 0.03 and 0.027; Co,-and 0.009; total Al,-and 0.039. The mechanical tests included hardness (Vickers), impact (Charpy V notch), and tension (JISY4), and structural observations were by an optical microscope and electronic microscope. In both the quenched and normalized plates the best impact property was obtained by 650°C-1 to 1.4 hr tempering, and at this condition the quenched-tempered plate was far better in the tensile property than the normalized-tempered one. These results can be explained by the change in the microstructure, especially the distributions and shapes of the separated substances. (NSA of Japan)

9183 EFFECTS OF IMPURITIES ON THE PLASTIC DEFORMATION OF MOLYBDENUM SINGLE CRYSTALS. Whitmire,

Larry Don. Houston, Tex., Rice Univ., 1966. 208p. Thesis.

Molybdenum single crystals were deformed in direct shear over the temperature range 78° to 400°K. All tests were conducted in a manner that placed maximum shear stress on the (011) -[1$\bar{1}$1] slip system. The effects of varying the impurity concentration on the shear stress–strain curve were determined. Two strain rates, 2×10^{-2} sec^{-1} and 2×10^{-4} sec^{-1}, were used, except at 78°K where tests were conducted at only the lower strain rate. Also evaluated were the effects of varying the impurity concentration on the activation volume. Electrical resistivity measurements at 4.2°K were used as a qualitative measure of the amount of impurities in the samples. Apparently the mechanical properties change drastically for very minute quantities of impurities, but the effect of additional impurities is considerably reduced as the amount of impurities increase. The influence of impurities was found to depend upon the temperature of deformation. At low temperatures the effect was limited to the initial stages of deformation and was obliterated by work hardening. Increasing temperatures caused a decrease in the influence of impurities. At 350° and 400°K the effect of impurities on the activation volume was below the limit of detection, but the stress–strain curves began to show features characteristic to the three-stage stress–strain curves obtained frequently for fcc metals. The presence of these features was found to be a function of the purity and strain rate. The activation volume was determined to decrease with strain at all temperatures. At 300°K and below, impurities were found to decrease the activation volume initially, but the change due to impurities was reduced during deformation. After large amounts of deformation, no differences in the activation volumes attributable to impurities were detectable. At 400°K the activation volume varied with strain in a manner that correlated with the three-stage stress–strain curves determined at this temperature. (TSS)

Structure and Phase Studies

Refer also to abstract 9123.

9184 (AD-633558) RESEARCH ON THE SAMARIUM-TYPE STRUCTURE OF INTRARARE-EARTH BINARY SYSTEMS. Final Report. Lundin, C. E. (Denver Research Inst., Colo.). Apr. 30, 1966. Contract Nonr-3661(02). 80p. (DRI-2326). CFSTI $3.00 cy, $0.65 mn.

A total of thirteen representative intra-rare-earth binary systems were studied to determine the criteria of formation and the characteristics of Sm-type structure formed in these alloy systems. The techniques used in the studies included metallography, x-ray diffraction analysis, hardness, thermal analysis, resistivity, dilatometry, density, electron-beam microprobe analysis, and liquid-metal-solution calorimetry. (TAB)

9185 (GEMP-61, pp 105-10) PHYSICO-CHEMICAL STUDIES OF Fe–Cr–Al-CLAD FUEL SYSTEMS. Edwards, H. S.; Bohlander, K. M. (General Electric Co., Cincinnati, Ohio. Nuclear Materials and Propulsion Operation).

Diffusion couples of Al, Cr, and Fe were fabricated and heat treated at 1000°C for 100 and 1000 hours. Cr diffused and formed a greater number of phases than Fe. Phase studies of Al–Cr–Fe–U fuel elements show extensive solubility of Al, Cr, and Fe in U but little solubility of U in the Al–Cr–Fe cladding alloys. (P.G.C.)

9186 (LA-3515) OBSERVATION OF THE MICROSCOPIC DISTRIBUTION OF OXYGEN AND CARBON IN METALS BY ^{3}He ACTIVATION. Holm, Dale M.; Basmajian, John A.; Sanders, Wm. Mort (Los Alamos Scientific Lab., N. Mex.). May 10, 1966. Contract W-7405-eng-36. 16p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The microscopic distribution of O_2 and C was observed by bombardment of metallographically polished samples with ^{3}He ions and autoradiography of the activated areas. Positrons from the activation products cause the exposure on nuclear track plates, and the positron annihilation radiation is used to determine both the proper exposure and the composite decay curve. Correlation of the unfolded decay curve with the autoradiograph indicates the isotope causing the exposure. Positional resolution of 0.0005 in. was obtained in samples having bulk C concentrations of about 250 ppM. (auth)

9187 (NUMEC-3428-26) GROWTH OF SINGLE CRYSTALS OF PLUTONIUM. Progress Report, July 1, 1966–September 30, 1966. (Nuclear Materials and Equipment Corp., Apollo, Pa.). Dec. 1966. Contract AT(30-1)-3428. 24p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Large grains of alpha-Pu (~1 mm × 0.9 mm) were grown using a variety of experimental conditions associated with a parametric study of the effects of varying cooling rate, pressure, and temperature of high-pressure release prior to cooling. All of the high-pressure runs in this series were done at 350°C with 4 hours holding times. The isothermal transformation of beta-Pu for 800 hours at 106.5 ± 0.5°C resulted in a highly sub-grained alpha-Pu microstructure having an average grain size of 0.4 mm. (auth)

9188 (RFP-658, pp 185-94) METALLOGRAPHIC AND X-RAY STUDIES OF ALPHA PLUTONIUM. Friddle, R. J.; Liptai, R. G.; Lloyd, L. T.; Odle, M. D. (Argonne National Lab., Ill.).

The metallographic and x-ray techniques developed to determine the microstructure of alpha Pu are described. (P.G.C.)

9189 NEUTRON DIFFRACTION BY TIME-OF-FLIGHT. Reichelt, J. M. A.; Rodgers, A. L. (United Kingdom Atomic Energy Authority, Aldermaston, Eng.). Nucl. Instrum. Methods, 45: 245-9(Dec. 1966).

A fast neutron chopper was used to make crystal structure investigations by neutron time-of-flight technique. The ability to collect data simultaneously from different crystal planes affords a distinct advantage over the conventional method. Data are presented for Al, Si, Pb, and Cu powder samples. The measurements show that the technique is capable of giving crystal structure amplitude factors with a reliability of better than 5%. (auth)

9190 ORDERED SOLID SOLUTION IN THE CHROMIUM–MOLYBDENUM SYSTEM. Prokoshkin, D. A.; Sidunova, O. I. (Moscow Higher Technical School). Izv. Vyssh. Ucheb. Zaved., Mashinostr., No. 7, 116-19(1966). (In Russian).

Specimens of cast and forged Mo were diffusion-coated with Cr, packed in Cr powder, and held at 1350 to 1600°C for 10 to 25 hr. The diffusion layer was found to consist of an external zone, with columnar grains oriented in the direction of diffusion flow; a (hardest) middle zone, with similar grains that could hardly be etched and had equal atomic contents of Cr and Mo; and an inner zone, with polyhedral grains. Analysis results showed that the external zone is a solid solution with variable concentration of components and a body-centered cubic lattice, while the middle zone has a tetragonal lattice. X-ray structural analysis of annealed alloy powders revealed the presence of tetragonal lattice lines and other odd lines that disappear under the effect of deformation. The appearance of a tetragonal lattice in Cr–Mo alloys may be associated with ordering of the solid solution. The appearance of the lines of a tetragonal lattice in all the alloys studied could be caused by dendritic heterogeneity. (ATD)

9191 NEW DIFFUSION INVESTIGATION OF THE PHASE FORMS IN THE SYSTEM Mg–Zr AS WELL AS ON THE SEEDING EFFECT BY ZIRCONIUM. Flammiger, K.; Sauerwald, F. (Martin-Luther-Univ., Halle, Ger.). Z. Anorg. Allg. Chem., 347: 310-17(Nov. 1966). (In German).

Experiments on the diffusion between compact Zr(wire) and Mg (surrounding cylinder) and between sintering Zr and Mg powders, especially at 640°C indicate as previously supposed the formation of at least one intermediate Mg–Zr mixed phase of medium Zr content. The results of crystallization experiments on the seeding action of Zr on Mg–Zr alloy formation suggest that Zr is probably active only after dissolution in Mg and by recrystallization in a Mg-containing, activated form. (auth)

9192 GRAPHICAL METHOD FOR INDEXING X-RAY POWDER PHOTOGRAPHS OF COMPLEX SUPERLATTICE STRUCTURES IN ALLOYS. Williams, R. P. (Manchester Univ., Eng.). Z. Kristallog., 123: 342-6(Nov. 1966).

A graphical method for indexing x-ray powder photographs of complex superlattices is described, and the example of ordered Ni_4Mo is worked out to demonstrate this method. The limitations and advantages of the method are briefly discussed. (auth)

9193 TEXTURE DISTRIBUTION ALONG CROSS SECTION OF ALPHA- AND GAMMA-DEFORMED AND QUENCHED URANIUM RODS. Zelenskii, V. F.; Kunchenko, V. V.; Roenko, N. M.; Kolomiets, L. D.; Stukalov, A. I. At. Energ. (USSR), 21: 192-7(Sept. 1966). (In Russian).

Roentgenographic analysis of texture distribution along the cross section of α- and γ-deformed and β- and γ-phase quenched uranium rods showed that the distribution density of P poles (hkl) and G_x growth index were functions of mechanical and thermal treatments. (tr-auth)

9194 EFFECT OF TEXTURE, GRAIN SIZE, AND COLD WORK ON THE PRECIPITATION OF ORIENTED HYDRIDES IN ZIRCALOY TUBING AND PLATE. Kearns, J. J.; Woods, C. R. (Westinghouse Electric Corp., Pittsburgh). J. Nucl. Mater., 20: 241-61(Sept. 1966). (WAPD-T-1902).

The effects of texture, grain size, and cold work on the precipitation of oriented hydrides in Zircaloy tubing and plate were investigated. Hydride orientations were measured in samples cooled under no applied stress and under a tensile stress of 20,000 psi.

In unstressed samples, the orientations were found to correlate with crystallographic texture as characterized by inverse pole figure data. In the stressed samples, hydride orientation depended on grain size and degree of residual cold work. (auth)

9195 THE STRUCTURE AND OCCURRENCE OF THE METASTABLE MONOCLINIC PHASE, α_b', IN URANIUM–MOLYBDENUM ALLOYS. Stewart, D.; Williams, G. I. (Fulmer Research Inst. Ltd., Stoke Poges, Eng.). J. Nucl. Mater., 20: 262-8(Sept. 1966).

The atomic positions of the metastable, monoclinic, α_b' phase occurring in U–Mo alloys were determined for a specimen containing 10 at. % Mo. The effects of alloy content and temperature on these positions were studied. It was shown that for specimens containing 9.2, 10, and 10.8 at. % Mo this structure is a result of a transformation, probably by a shear process, from a tetragonal phase based on the body-centered-cubic structure of γ U. The relation between the atomic positions in the monoclinic cell and in the parent γ phase and equilibrium α phase of U is discussed. (auth)

9196 AN EMISSION ELECTRON MICROSCOPY STUDY ON THE HEAT TREATMENT INDUCED GRAIN GROWTH OF MOLYBDENUM AND TANTALUM. Morlin, Zoltan; Tremmel, Janos (Research Lab. Chemical Structures, Budapest). J. Microscop., 5: 431-40(1966).

Grain growth of Mo and Ta plates was investigated with an emission electron microscope at 1000 to 1400°C. Various aspects of growth, growth velocities, the orientation of the grains, and the possibility of oxide layer formation are considered. The isothermal time dependence of the growth of the average grain size yielded sigmoidal type functions, well known from the kinetics of recrystallization. The isothermal change of the size of single grains could not be described by a simple, linear function. The short-term interval growth velocities of the individual grains changed within broad limits; sometimes growth stopped, and in many cases liquid-like growth (very rapid coalescence of 2 or more grains) was observed; differences in brightness of the various grains seemed to be due to the orientation dependence of the work function of the thermionic electron emission. (BBB)

9197 NOVYE ISSLEDOVANIYA TITANOVYKH SPLAVOV. TRUDY 6-GO SOVESHCHANIYA PO METALLOKHIMII METALLOVEDENIYU I PRIMENENIYU TITANA I EGO SPLAVOV. (New Studies of Titanium Alloys. Bulletin of the 6th Conference on Metal Chemistry, Metallography, and Applications of Titanium and Its Alloys). Kornilov, I. I.; Boriskina, N. G. (eds.). Moscow, Izdatelstno Nauka, 1965. 336p.

Fifty two articles are included on the mechanism and kinetics of phase transformations; formation of metastable phases and their effects on the physicochemical properties of Ti alloys; and effects of various alloying elements on Ti and Ti alloy corrosion and electrochemical behavior. Properties, plastic deformation and disintegration, effects of thermal treatment, welding and heat resistance of Ti and Ti alloys are discussed. Phase diagrams are analyzed for various alloys including Ti–Zr, Ti–W, and Ti–V alloys. (R.V.J.)

Radiation Effects

9198 (GEMP–61, pp 33-54) RADIATION EFFECTS ON FAST REACTOR CLADDING AND STRUCTURAL MATERIALS. Moteff, J.; Kingsbury, F. (General Electric Co., Cincinnati, Ohio. Nuclear Materials and Propulsion Operation).

Radiation effects on the physical properties of recrystallized W rods and on Mo–Re–W alloys are reported. Ductility of the irradiated materials decreased but tensile strength increased. Annealing at 1100 to 1200°C restored ductility of the W and similar treatment at 451 to 690°C restored that of the alloy. Hot hardness measurements were made on fast neutron irradiated W single crystals and on polycrystalline specimens of Mo, Re–W, Mo–Re–W, Mo–Ti–Zr, and Mo–Re alloys. Electromicroscopic structure studies revealed no fundamental differences between irradiated, irradiated and annealed, and unirradiated materials. (P.G.C.)

9199 (GEMP–61, pp 119-32) EFFECT OF RADIATION ON HEAT-RESISTANT METALS AND ALLOYS. Moteff, J.; Smith, J. P. (General Electric Co., Cincinnati, Ohio. Nuclear Materials and Propulsion Operation).

Results of irradiation tests on Hastelloy and ferritic pressure vessel steels are reported. Specimens of the alloy irradiated and tested at 760°C show a reduction in rupture life by factors of 10 to 15 compared with unirradiated control specimens. It is indicated that long heat treatments are required to restore irradiation-induced loss in rupture life. Resistivity of ferritic steels is reduced as a result of ambient-temperature irradiation in some ranges, and reduction increases with increase of fast neutron flux. (P.G.C.)

9200 (N–66–27530) RADIATION EFFECTS ON SILVER AND ZINC BATTERY ELECTRODES. IV. Interim Report, January–April 1966. Nicholson, M. M.; Recht, H. L.; Kelchner, R. E.; McCollum, W. A. (Atomics International, Canoga Park, Calif.). May 27, 1966. Contracts NAS7-100; JPL-951109. 37p. (NASA-CR-75394; AI-66-83). CFSTI $3.00 cy, $0.65 mn.

Gamma radiation effects on silver oxide battery electrodes at 90 and 60% states of charge were studied in experiments designed to detect changes in discharge capacity, gas evolution, and solid material loss. A voltage follower circuit was incorporated into the automatic capacity measuring equipment to record and control the test electrode potential against a reference electrode. A capacity increase of 14% was noted in cells receiving a dose of 7×10^7 rads of ^{60}Co radiation while cycling at 90 ⇌ 95% charge. Control cell capacity increased 15%. Radioinduced capacity changes are small compared with the combined effects of cycling, temperature, and time. Solid material loss from Ag electrodes was higher in the irradiated cells than in the controls. At the 90% charge level there was a 3% net loss in Ag content, and a 1.5% loss at the 60% charge. The gas evolution data were improved by an exchange procedure that established a N_2 atmosphere in the cells immediately before irradiation. The gradual formation of H_2 was again noted in irradiated cells, with the final gas phase containing as much as 19%. After cycling, both irradiated and control cells contained large amounts of O_2. (STAR)

9201 (RFP–658, pp 76-83) REMOTE HANDLING TECHNIQUES USED IN THE STUDY OF FISSION PRODUCT DIFFUSION IN IRRADIATED METALS. Leighton, Stuart A.; Stapp, Willis J. (General Electric Co., Cincinnati, Ohio. Nuclear Materials and Propulsion Operation).

Techniques are described for remote handling in studies of fission product retention by refractory metals at high temperatures. The procedures described encompass mounting sections as a conductive metallographic mount, controlling the material removed in grinding and polishing, anodizing the polished surface, and stripping the anodized surface film for evaluation by gamma-ray scintillation spectroscopy. (auth)

9202 (RFP–658, pp 84-96) AN ALPHA-GAMMA METALLOGRAPHIC FACILITY. McGrath, F. E. (Battelle Memorial Inst., Columbus, Ohio).

An alpha-gamma facility is described. The facility permits handling radioactive materials under protective atmospheres. It was designed to provide complete containment of the radioactive materials so that radioisotopes as well as nuclear fuels can be studied within the facility. (auth)

9203 (UCRL–17078) RADIATION INDUCED DEFECTS IN MOLYBDENUM. Rao, Prakash (California Univ., Berkeley. Lawrence Radiation Lab.). Sept. 1966. Contract W-7405-eng-48. 47p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Thesis.

A study, using transmission electron microscopy and field-ion microscopy, of the substructure of neutron-irradiated Mo revealed induced damage in the form of small dislocation loops. Bright field electron micrographs give a quantitative estimate of the extent of this damage, and strain contrast imaging in dark field allowed the loop plane and Burgers vector to be established. Analysis of these induced defects, using different imaging conditions in dark field, showed that the loops are predominantly of the type $\{110\}\langle 111\rangle$ [i.e., loop plane $\{110\}$ and Burgers vector $(a/2)\langle 111\rangle$]. The extension and applicability of the strain contrast theory to radioinduced defects in BCC metals was examined, particularly its usefulness in predicting the interstitial or vacancy character of the defects. Contradictions arise when low-order reflections are used, but the results are less ambiguous for high order reflections and edge on defects. The evidence presented indicates that the defect structure is primarily interstitial. The irradiation behavior of Mo is discussed in terms of present observations. Interstitial impurity atoms play an important role in determining the nature of defects present in the as-irradiated and irradiated-annealed states. (auth)

9204 ELECTRON MICROSCOPE OBSERVATIONS OF GAS BUBBLES IN NEUTRON IRRADIATED Al–Li ALLOYS. Shiraishi, Kensuke; Murata, Tomomi (Japan Atomic Energy Research Inst., Tokyo). J. Nucl. Sci. Technol. (Tokyo), 3: 466-72(Nov. 1966).

The electron microscope was used to observe the behavior of He gas bubbles in neutron irradiated Al–Li alloys. In the case of high He concentration, the gas bubbles were observed as small white or black dots in specimens as irradiated. The bubbles initiated appreciable growth upon heating to 400°C. They precipitated preferentially along the subgrain boundaries and dislocations, as well as along the grain boundaries. The size of the bubbles, observed in a specimen heated to 550°C, ranged from about 10 Å to

1 μ. The shape of the bubbles in the specimen heated to 400°C was hexagonal or octagonal in the two-dimensional projection and a polyhedral image of the larger bubbles was clearly observed. The number of planes that bound the polyhedral bubble increased with increasing temperature of heating. Spherical bubbles were also observed. (auth)

9205 BACKGROUND INTERNAL FRICTION OF SOME PURE METALS AT LOW FREQUENCIES. Routbort, J. L.; Sack, H. S. (Cornell Univ., Ithaca, N. Y.). J. Appl. Phys., 37: 4803-5(Dec. 1966). (NYO-2471-18).

The background internal friction of Al, Cu, and Mg at 300°K was investigated as a function of plastic deformation, γ-ray and neutron irradiation, and frequency (0.001 to 40 kc). The results suggest that the Granato–Lücke vibrating-string model does not adequately describe the results at low frequencies. (auth)

9206 EVIDENCE FOR A HELICAL CRYSTALLOGRAPHIC TEXTURE IN URANIUM BARS OF MAGNOX-CLAD FUEL ELEMENTS. Duckworth, F. C.; Speight, M. V. (Central Electricity Generating Board, Berkeley, Eng.). J. Nucl. Mater., 20: 307-13(Sept. 1966).

The effects of irradiation on U fuel element bars containing a helical crystallographic texture are analyzed. The relation between the magnitudes of the resulting axial and torsional strains is derived and compared with an empirical relation determined from experimental data from certain irradiated fuel elements discharged from the Berkeley and Bradwell reactors. The comparison provides evidence for the hypothesis that the U bars contain a helical crystallographic texture and enables further information about the nature of this texture to be deduced. (auth)

9207 STRUCTURAL TRANSFORMATION IN A NICKEL–CHROMIUM ALLOY (80 Ni/20 Cr) UNDER IRRADIATION. II. Astrahantzev, S. M.; Konnov, Yu. I. (Kurchatov Atomic Energy Inst., Moscow). J. Nucl. Mater., 20: 323-7(Sept. 1966).

The effect of irradiation on the mechanical (tensile) properties of Ni–Cr alloy with 21 wt % Cr was studied. The ultimate tensile strength, yield strength, and elongation were determined at different temperatures. The specimen hardness is shown to change in the process of heating. A metallographic analysis was carried out. Changes of properties of the Ni–Cr alloy are explained in terms of the effect of irradiation on the rate of K-state formation in the alloy. The results of the investigation agree with the conclusions drawn in an earlier investigation. (auth)

9208 ANNEALING OF FAST NEUTRON DAMAGE IN IMPURITY-CONDUCTING n-TYPE GERMANIUM. Wolf, E. L.; Compton, W. Dale; Depp, S. W. (Univ. of Illinois, Urbana). J. Appl. Phys., 37: 4941-3(Dec. 1966).

An annealing study of neutron-irradiated Ge containing 2.2×10^{17} cm^{-3} Sb is described. The samples originally exhibit a temperature-independent resistivity below 10°K, corresponding to an impurity conduction band distinct from the conduction band of the Ge. Irradiation introduces a small activation energy ϵ_2 in the resistivity below 10°K. The activation energy ϵ_2 and the 78°K carrier concentration change anneal together at about 300°C. The annealing results are compared with those obtained on more pure Ge irradiated with x rays. (auth)

9209 RADIATION HARDENING IN STRAINED NaCl SINGLE CRYSTALS. Agullo-Lopez, F. (Junta de Energia Nuclear, Madrid). J. Appl. Phys., 37: 4883-7(Dec. 1966).

The effect of room-temperature γ-ray radiation on the stress–strain behavior of prestrained NaCl single crystals was investigated. After irradiation, a large increase in macroscopic flow stress and an initial soft region were observed. Experimental data on the increase in flow stress vs γ dose are reported for different levels of prestraining. Finally, possible hardening mechanisms are explored in the light of experimental behavior. (auth)

9210 EFFECT OF FISSION FRAGMENTS ON THE MICROSTRUCTURE OF AN AUSTENITIC STAINLESS STEEL. Rosenbaum, H. S.; Armijo, J. S.; Wolff, U. E. (Vallecitos Nuclear Center, Pleasonton, Calif.). J. Nucl. Mater., 21: 225-31(Feb. 1967).

Type-304 stainless steel, in contact with nuclear fuel, had a duplex surface layer 5 to 10 μm thick. This zone is within the range of, and is believed to be caused by, the recoiling fission fragments from irradiated urania in which 1.2 to 3×10^{20} fissions/cm^3 had occurred. Examination of the zone showed that both layers of the duplex structure are austenite of the same crystallographic orientation as the underlying austenitic matrix. Both layers are harder than the underlying matrix. The two layers of the duplex zone are distinguishable only by their etching characteristics. Possible reasons for the existence of a duplex, rather than a single layer, are discussed. (auth)

Ceramics and Cermets

Refer to abstract 9050.

Corrosion and Erosion

Refer to abstract 10216.

Preparation and Fabrication

Refer also to abstracts 9221, 10162, 10218, 10223, and 10224.

9211 (AD-638219) FABRICATION OF BERYLLIUM OXIDE RADOMES BY PYROLYTIC DEPOSITION. Final Engineering Report, May 28, 1964–June 1, 1965. Taebel, W. A.; Hoekstra, G. (National Beryllia Corp., Haskell, N. J.). Contract NOw-64-0512. 45p. CFSTI $3.00 cy, $0.65 mn.

An investigation was made of monolithic beryllia ceramics, BeO foam structures, and structures reinforced with beryllia fibers. A chemical vapor deposition process involving a reaction between a halide of Be and water (hydro-pyrolytic reaction), and pyrolysis of an organic adduct of Be were studied as means of preparing continuous deposits of beryllia. The vapor phase oxidation of Be metal was also investigated as a process for preparing beryllia fibers or whiskers. Deposits of limited thickness were prepared by the hydropyrolytic reactions involving O_2 donor systems such as either water or NO_2. For either system, evidence points toward the fairly rapid attainment of equilibrium conditions wherein the deposit of beryllia produced by the reactions is eroded by the volatile non-metallic oxides of the reactants or products of the reactions. Preliminary results indicated that adherent, dense, and hard deposits of conceivably unlimited thickness could be prepared by the pyrolysis of a volatile organic adduct of Be. Sporadic success was attained in growing beryllia fibers by the vapor phase oxidation of Be metal. (TAB)

9212 (AERE-R-5241) SOL-GEL STUDIES. PART I. URANIA-PREPARATION OF SOLS, AGGREGATE, AND SPHERES. Lane, E. S.; Fletcher, J. M.; Fox, A. C.; Holdoway, M. J.; Hyde, K. R.; Lyon, C. E.; Woodhead, J. L. (Atomic Energy Research Establishment, Harwell (England)). Dec. 1966. 18p. Dep. mn. BIS $0.70. HMSO 3s. 6d.

Various routes for the production of uranium(IV) sols have been examined and one selected for the production of 100 g batches of urania as microspheres and as aggregate. Uranyl nitrate solutions were catalytically reduced with hydrogen at atmospheric pressure to U(IV) from which hydrated U(IV) oxide was precipitated, centrifuged and washed prior to being peptized to a sol. The sols were gelled either by evaporation to give aggregate, or in an immiscible organic phase to give microspheres. After calcination at 1150°C in hydrogen, the O/U ratio in the products was 2.00 + 0.02 and the densities were 95–96% of the theoretical value. The crushing strength of individual microspheres (250–350μ) was up to 5 kg. (auth)

9213 SOME PROBLEMS IN DOMESTIC UO_2 FUEL. Ueda, Ryuzo (Japan Atomic Energy Research Inst., Tokyo). Nippon Genshiryoku Gakkaishi, 8: 617-20(Nov. 1966). (In Japanese).

The present status of research and development in Japan of UO_2 fuel, and some problems encountered in the fabrication of UO_2 fuel power for reactors are described. (auth)

9214 CARBOTHERMAL METHOD OF PREPARATION OF CHROMIUM, MOLYBDENUM, AND ZIRCONIUM BORIDES. Gorbunov, A. E. Porosh. Met., Akad. Nauk Ukr. SSR, No. 11, 52-6 (Nov. 1966). (In Russian).

It is shown that it is possible to prepare on an industrial scale the borides of chromium, molybdenum, and zirconium from the oxides of these elements, boric acid, and soot. The effect of the charge composition, temperature of reaction, and rate of passage through the furnace on the composition of chromium, molybdenum, and zirconium borides is determined. (auth)

9215 ON THE EFFECT OF TiO_2 ADDITIONS ON SINTERING OF UO_2. Matzke, Hj. (Atomic Energy of Canada Ltd., Chalk River, Ont.). J. Nucl. Mater., 20: 328-31(Sept. 1966).

Small additions of TiO_2 are known to increase the density of sintered UO_2. It is shown that this effect coincides with an increase in the diffusion rate of the slower-moving U ion. Quantitative metallography and measurement of the gas release following high-dose ion bombardment show that small amounts of Ti are soluble in UO_2. Possible mechanisms by which TiO_2 affects the disorder of UO_2 are discussed. Reduction of TiO_2 and interstitial solution of the small Ti ions are favored. Similar experiments are reported for $ThO_2 + TiO_2$. (auth)

9216 EFFECT OF PRECIPITATION CONDITIONS OF AMMONIUM POLYURANATE ON SINTERABILITY OF URANIUM DIOXIDE. Dembinski, Wojciech; Deptula, Andrzej; Rykowski, Stanislaw (Inst. of Nuclear Research, Warsaw). Nukleonika, 11: 567-74(1966).

The conditions of precipitation of ammonium polyuranate affect its physical state, which in turn determines the sinterability of UO_2 powders, obtained by calcination and reduction in H_2 atmosphere. It was found that powders obtained from polyuranates of small and uniform grain, having large specific surface and high density, show better sinterability. (auth)

9217 METHOD FOR BONDING BERYLLIUM OXIDE TO GRAPHITE. DeBruin, H. J. (to U. S. Atomic Energy Commission). U. S. Patent 3,300,852. Jan. 31, 1967.

A method is described for bonding BeO bodies to graphite having a randomly oriented crystallographic structure by interposing thin layers of Pt metal between abutting surfaces of the respective bodies and vacuum heating to 1550°C but below 1773°C for a sufficient time to cause diffusion of the Pt into the bodies and bond the abutting surfaces together. (AEC)

9218 METHOD OF PREPARING OXIDES FOR NEUTRONIC REACTOR CONTROL. Leitten, C. F. Jr.; Potter, R. A.; McDonald, R. E. (to U. S. Atomic Energy Commission). U. S. Patent 3,300,848. Jan. 31, 1967.

A method is described for preparing stoichiometric rare earth powders of the class consisting of oxide compounds of rare earth metals, such as molybdates, tungstates, titanates, and mixtures of these. The method comprises the steps of inert-atmosphere melting the desired compound to form a reduced rare earth compound melt, solidifying the fused melt, heating the fused compound in an oxidizing atmosphere to at least 1000°C to achieve stoichiometry and then crushing the compound to produce stoichiometric rare earth powders in the particle size range of from 44 to 149 microns. (AEC)

9219 PREPARATION OF ACTINIDE METAL CARBIDE MICROSPHERES. Pilloton, R. L.; Hammer, R. L. (to U. S. Atomic Energy Commission). U. S. Patent 3,300,284. Jan. 24, 1967.

A method is described for preparing dense actinide carbide microspheres from correspondingly dense actinide oxide microspheres having a density of at least 97% of theoretical. The oxide microspheres are heated without melting in a bed of C to a temperature sufficient to convert in situ the oxide to the carbide. (AEC)

9220 FUEL MATERIAL FOR NUCLEAR REACTORS AND PROCESS AND APPARATUS FOR ITS MANUFACTURE. Rachor, Lothar; Lotz, Horst (to Nukem Nuklear-Chemie und- Metallurgie Gesellschaft mbH). U. S. Patent 3,284,314. Nov. 8, 1966. Priority date Sept. 5, 1963, Germany.

A process is described for the manufacture of spherical fuel elements having an outer diameter of about 60 mm and a hollow portion in the center of about 36 mm diameter. The outer shell is formed of graphite and the fuel material is in the form of finely to grossly dispersed particles combined with a bonding agent formed into a thin layer on the inner surface of the hollow graphite sphere. The hollow in the center of the sphere is filled with a neutron-physically favorable high-temperature-resistant mass, such as graphite powder. The filling opening in the sphere is closed with a plug cemented in place, and the entire assembly is fired at 1000 to 2000°C so that the binder on the inner layer as well as the plug are coked. (B.L.M.)

Properties Evaluations

Refer also to abstract 8236.

9221 (AAEC-TM-334) AN ASSESSMENT OF POSSIBLE PROTECTIVE COATINGS FOR BeO AND BeO BASED REACTOR FUEL ELEMENTS. Reeve, K. D. (Australian Atomic Energy Commission Research Establishment, Lucas Heights). July 1966. 23p. Dep. mn.

Beryllium oxide based reactor fuel elements may be required to operate in moist air at temperatures in the range 1000 to 1200°C. In this environment, unprotected fuel elements would lose excessive amounts of BeO as $Be(OH)_2$. Methods of preventing this loss by means of non-reactive coatings are considered. By application of established coating principles and also criteria specific to this requirement, the most promising materials are found to be Al_2O_3 and $MgAl_2O_4$. $MgAl_2O_4$ would be difficult to apply to form a dense crack-free coating; Al_2O_3 could be applied by various methods, the best of which appear to be isostatic pressing, slip casting or spraying, and vapor deposition. It is recommended that a detailed thermal stress analysis be carried out on an Al_2O_3-coated fueled BeO sphere, and that experimental work should be concentrated on isostatic coating. (auth)

9222 (SC-DR-66-593) ENGINEERING STUDY OF THE TENSILE STRENGTH OF FERROELECTRIC CERAMICS. Dungan, R. H. (Sandia Corp., Albuquerque, N. Mex.). Nov. 1966. Contract AT(29-1)-789. 54p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

A hoop test apparatus for measuring the tensile strength of ceramic materials is described. The use of this apparatus to investigate the effects of grain size on the tensile strength of selected compositions is discussed along with the effects of treatments, such as poling, electroding, and the effects of surface condition on tensile properties. In general, hot pressed materials are stronger than conventionally sintered materials; poling decreases the strength of $PbZrO_3$-$PbTiO_3$ (PZT material) by about 25%; and, the tensile strength of PZT is independent of grain size over the range of about 1 to 15 microns, in contrast to the behavior of typical ceramic materials. Improving the surface finish increased the tensile strength very little while certain heat treatments reduced the strength by nearly 50%. (auth)

9223 (UCRL-17105) THE EFFECT OF PLASTIC INSTABILITY OF MgO SINGLE CRYSTALS IN COMPRESSION. Cropper, Donald Riddick (California Univ., Berkeley. Lawrence Radiation Lab.). Sept. 2, 1966. Contract W-7405-eng-48. 44p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Thesis.

The creep of MgO single crystals loaded in compression was studied under conditions where plastic buckling was likely to occur. The degree of end constraint characteristic of these tests strongly affects the possibility of buckling. Experiments suggest that buckled columns creep at a lower rate than do columns that remain straight. At temperatures around 1300°C and above, the creep rate appears to be particularly sensitive to the nature of the crystal surface prior to deformation. At 1200°C the stress dependence of the creep strain rate can be represented as a power law with a stress exponent of 4.7. This is in reasonable agreement with Chang's theory of creep by diffusion-controlled dissolution of dislocation dipoles and loops. (auth)

9224 HIGH-TEMPERATURE MATERIALS AND THE REFRACTORY TREATMENT. Kawashima, Chihiro (Tokyo Inst. of Tech.). Kagaku Kogyo, 16: No. 8, 41-51(Aug. 1965). (In Japanese).

Studies were made on the physical properties and refractory treatment of high-temperature materials, by the coating and ablation tests with a plasma jet, by coating with β-SiC and pyrolytic graphite by the chemical plating method, and the formation of crystals and the development of a refractory duct for the MHD power generation. Of the various duct materials tested, MgO was the best. The sintered magnesia pieces, assembled mosaically, showed good results. In the ablation test of missile nose cones by a plasma jet, glassfiber (FRP) and refractory ceramics were shown to be strong by heat resisting. The honeycomb structure (metal-plastic-ceramic composite) exhibited an excellent refractory effect. In coating metals and graphite by a plasma jet, the induction-coupled plasma torch method can be used to much advantage. In the vapor plating method, coating by a gas-phase reaction at high temperature was important. Chemical platings included coating with a carbide, oxide, and refractory metal; these have advantages, but have drawbacks such as the difficulty in finding suitable reaction conditions, high costs of the reaction compounds, and danger in the handling. (NSA of Japan)

9225 MODIFICATIONS OF THE STRUCTURE OF PURE OR ALLOYED ZIRCONIUM OXIDE BY A DIRECT ELECTRIC CURRENT AT HIGH TEMPERATURE. Beranger, G.; Lacombe, P. (Ecole Nationale Superieure des Mines, Paris). Rev. Int. Hautes Temp. Refract., 3: 235-42(July-Aug. 1966). (In French).

The modifications caused in zirconia by the passage of a continuous electric current at high temperature were studied to define the nature of the ions diffusing across the oxide. Preparation and experimental techniques are described. Resistance of the sample decreased as a function of time depending on the initial electric field and temperature. These modifications were accompanied by a morphological color change of white to black and a weight decrease. In some cases a thin metallic deposit appeared on the cathode face. These results are discussed in some detail. Electron-microprobe and x-ray studies were made of the black zirconia. Results confirmed the existence of an ionic conductivity in this oxide at 850 to 1,100°C. It is shown that diffusion in this oxide consists principally of O ions. These ions under the effect of the electric field move toward the anode causing the production of a black sub-stoichiometric oxide. (J.S.R.)

9226 IMPURITY-DOPE EFFECTS ON THE ANELASTICITY OF GRAPHITE. Tsuzuku, Takuro; Saito, Mitsuhiro (Nihon Univ., Tokyo). Jap. J. Appl. Phys., 6: 54-64(Jan. 1967).

By means of a resonant bar technique, the impurity-dope effects on the anelastic properties of various graphites have been investigated at temperatures ranging from 290°K down to 4.2°K. A pronounced peak in the internal friction vs temperature diagram for polycrystalline graphite has been found to grow up, with stepwise bromination up to 0.25% Br/C, and to shift toward higher temperature side from the original position around 50°K. Also for the pyrolytic graphite boronated to 0.5 at. % a similar relaxation peak was found around 80°K. As to the background component, an analysis in the framework of the Granato–Lücke theory was examined on the resonant frequency vs temperature relation, and has yielded the activation energy values for thermal depinning of dislocations as follows: 0.04 eV and 0.03 eV before and after the bromination respectively, and 0.006 eV for the boronateds. An interpretation of these observations is given, based on the duplex role of impurities in graphite, viz. pinning function and viscous drag effect to dislocations. (auth)

9227 ELECTROLYSIS AND ION TRANSPORT MECHANISM IN URANIUM DIOXIDE. Iida, Shoji (Mitsubishi Atomic Power Inds., Inc., Ohmiya, Japan). Jap. J. Appl. Phys., 6: 77-82 (Jan. 1967).

Uranium dioxide was electrolyzed in the temperature range between 20° and 1000°C. A difference in O/U ratios between anode and cathode sides was observed. Electrical conductivity measurements indicate that at low temperature most of the carriers are electrons, and at high temperature ionic conductivity is observable, the most predominant ionic carrier being oxygen ions. Electrical conductivity at high temperature is considered to be due to both electrons and ions. The mobilities of uranium ion and oxygen ion were calculated at 1000°C as $\mu_u = 7.35 \times 10^{-26}$ cm^2/volt · sec and $\mu_0 = 2.1 \times 10^{-5}$ cm^2/volt · sec, respectively. Schottky defects are considered to be the predominant ion-transport mechanism from the result of transference number; Schottky defect formation is expected at either low or high temperatures, along with Frenkel defect formation. (auth)

9228 THERMODYNAMIC PROPERTIES OF URANIUM CARBIDES. Leitnaker, J. M.; Godfrey, T. G. (Oak Ridge National Lab., Tenn.). J. Nucl. Mater., 21: 175-89(Feb. 1967). (ORNL-P-2185).

Thermodynamic and phase information relative to the U–C system was analyzed and shown to be consistent. The anomalously high heat capacity of UC_2 was justified in the analysis. Thermal functions were calculated for UC and UC_2, using a non-zero S^0_0 (0.60 eu) for the dicarbide. For uranium $\Delta H^0_{298,vap}$ was calculated to be 123.7 ± 1.3 kcal/mole. (auth)

9229 XENON MIGRATION AND TRAPPING IN DOPED ThO_2. Matzke, Hj. (Atomic Energy of Canada Ltd., Chalk River, Ont.). J. Nucl. Mater., 21: 190-8(Feb. 1967).

The effect of small amounts of additives of different valence (Y_2O_3 or NB_2O_5) on Xe migration and on radioinduced trapping in ThO_2 was studied to improve the understanding of the mechanism of rare gas diffusion in UO_2 and ThO_2. ThO_2 was chosen since it has the same lattice structure as UO_2 and the valence of Th^{4+} is unlikely to change to compensate for the different valence of the impurity. The diffusion of ^{233}U was measured at 1400 and 1550°C in both doped and undoped ThO_2. More rapid diffusion in Nb_2O_5-doped ThO_2 and less rapid diffusion in Y_2O_3-doped ThO_2 were found. This indicated that doping was effective in producing extrinsic behavior. Xe was introduced into the specimens by ion bombardment. At low bombardment dose, doping did not appreciably affect the release indicating that Xe does not diffuse via single vacancies on either sublattice. As alternatives, diffusion via interstitial sites or in small vacancy clusters of constant size remained. Temporary trapping (retarded gas release) was observed at higher doses. Additions of Nb_2O_5 decreased and additions of Y_2O_3 increased this retardation, thus showing that impurities can affect trapping phenomena. (auth)

9230 ON SOME PECULIARITIES OF CARBON DIFFUSION IN MOLYBDENUM CARBIDE. Shovensin, A. V.; Shcherbedinskii, G. V.; Minkevich, A. N. Porosh. Met., Akad. Nauk Ukr. SSR, No. 11, 46-51(Nov. 1966). (In Russian).

The coefficients of carbon diffusion in molybdenum carbide Mo_2C were determined for two cases: (1) in previously grown (self diffusion), (2) diffusion in the process of carbide layer growth (heterodiffusion). Temperature dependences are found for diffusion coefficients, which are expressed by the ratio $D = 0.3 \exp(-67{,}000/RT)$ cm^2/sec and $D = 3.17 \times 10^3 \exp(-78{,}000/RT)$ cm^2/sec respectively. Heterodiffusion coefficients at all temperatures are approximately two orders higher than self-diffusion coefficients. This can be the consequence of the dependence of thermodynamic carbon activity in molybdenum carbide on the concentration. (auth)

9231 STUDY OF THE SPEED OF VAPORIZATION, OF THE VAPOR PRESSURE, OF THE COMPOSITION DISCONTINUITY, AND OF CERTAIN THERMODYNAMIC PROPERTIES OF REFRACTORY COMPOUNDS AT TEMPERATURES UP TO 3000 DEG C. Fesenko, V. V.; Bolgar, A. S.; Gordienko, S. P. (Institut des Cermets et des Alliages Speciaux, Kiev). Rev. Int. Hautes Temp. Refract., 3: 261-71(July-Sept. 1966). (In French).

A systematic study was made of the carbides of Ti, Zr, Hf, Nb, Ta, and Cr and of zirconium diboride and lanthanum hexaboride. The compositions of the carbides of Ti, Zr, Hf, Nb, and Ta studied in the temperature region from 2,770 to 3,370°K were determined and the results tabulated. The results show that in the regions studied the carbides of Ti, Zr, and Hf are close to stoichiometry, but under the same conditions the Nb and Ta carbides change considerably in composition. This composition change is caused by evaporation of C. The energies of formation, atomization, and dissociation reactions of the refracted carbides were determined and tabulated. The character of the chemical bonding and its structure were considered. Chromium carbide, zirconium diboride, and lanthanum hexaboride were studied by the effusion method and the vapors were analyzed by mass spectrometry. The results obtained are tabulated. (J.S.R.)

9232 EFFECT OF THE POROSITY AND CRYSTALLINE ORIENTATION OF YOUNG'S MODULUS OF ARTIFICIAL GRAPHITE. Barrachin, A. M.; Jouquet, G.; Micaud, G.; Pattou, F. (CEN, Saclay, France). J. Nucl. Mater., 20: 294-302(Sept. 1966). (In French).

The porosity of artificial graphite is assumed to play a different part, according to its nature, in the elastic properties of the material. The macroporosity between the grains can be connected by a linear function to the Young's modulus. By means of simple hypotheses involving the elastic properties of the material, the crystal orientation, and the orientation of microcracks, a homographic relation can be established between the Young's modulus and the microporosity produced in the grains during cooling following graphitization. The development of the microporosity on heating is deduced from the known thermal expansion coefficients of the crystal and of the polycrystalline material. From this set of relations the theoretical thermal variation of the Young's modulus of a nonporous artificial graphite can be calculated. This theoretical evaluation is compared with the experimentally determined value for special very dense graphites in which the crystal orientation tends towards that of the monocrystal. (auth)

9233 DEFECTS IN PuO_{2-x}: DENSITY MEASUREMENTS AT HIGH TEMPERATURE. Atlas, L. M.; Schlehman, C. J.; Readey, D. W. (Argonne National Lab., Ill.). J. Amer. Ceram. Soc., 49: 624-5(Nov. 21, 1966).

A method is described for measuring density of PuO_{2-x} at 750°C. The high-temperature He pycnometer used is illustrated. It was found that with increasing deviation from stoichiometry, the experimental densities decrease at about double the rate required by the presence of vacancies (metal interstitials would increase the density). However, the general patterns of density change are sufficiently similar for the vacancy model to be highly probable. Experimental and theoretical densities of PuO_{2-x} at 750°C are tabulated. (P.C.H.)

9234 ELECTRICAL PROPERTIES OF CERAMIC INSULATORS AT HIGH TEMPERATURES AND IN RADIATION FIELDS. Bregar, John Francis. Tucson, Ariz., Univ. of Arizona, 1966. 93p.

Thesis.

The electrical conductivities of beryllia, zirconia, and thoria were measured from 300°K to temperatures as high as 2000°K, and in a reactor radiation environment corresponding to power densities up to 6 kW/liter. The experimental data were used to calculate the constants in the mathematical model of Dau (1965), which predicted a functional behavior of the form $\sigma_r = PG \exp(-W/kT)\, T^{\frac{1}{2}}$. Certain combinations of insulating materials and metallic electrodes may cause permanent changes in the insulator as a result of the combined influence of high temperature and high leakage currents. This phenomenon was observed for zirconia and thoria at temperatures over 1000°K and leakage currents approaching one ampere. Experimental evidence indicated that the metal oxide lattice was depleted of oxygen, leaving metal atoms behind. The electrical breakdown strength of beryllia was measured over the temperature range of 300°K to 1000°K and in an x-ray field up to 2 kR/hr. The experimental data confirmed theoretical predictions that the square of the breakdown field strength is proportional to the logarithm of the initial temperature and decreases with sample thickness. Experimental data were used to predict a critical temperature for beryllia of 1134°K ± 13°. This value for the critical temperature indicates that the value of beryllia as an insulator for localized high-voltage stresses at temperatures over 1000°K is seriously questioned. The theory that the

breakdown field strength for beryllia is independent of radiation environment was confirmed for fields up to 2 kR/hr. This radiation field is several orders of magnitude lower than that produced by a nuclear reactor operating at power levels up to 6 kW/liter. (Dissertation Abstr.)

Structure and Phase Studies

9235 (BNWL-SA-238) FRACTURE OF URANIUM DIOXIDE. Daniel, J. L. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.); Takahashi, Shuichiro (Mitsubishi Atomic Power Industries, Inc., Omiya (Japan). Engineering and Research Lab.). Nov. 1, 1965. Contract AT(45-1)-1830. 18p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The metallography of UO_2 indicates that the material displays microplasticity, with dislocation movement on the order of 100 μ at room temperature, and that this plasticity influences the fracture characteristics. (P.G.C.)

9236 (GA-6450) PREPARATION OF BERYLLIA THIN SECTIONS FOR OPTICAL MICROSCOPY. Cochran, F. L.; Wallace, W. P. (General Dynamics Corp., San Diego, Calif. General Atomic Div.). Aug. 13, 1965. Contract AT(04-3)-187. 25p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

A technique for glove-box preparation of thin sections of sintered BeO and $BeO-UO_2-ThO_2$ fuel pellets is described. The basic technique employs automatic equipment, but an alternative method using manual grinding and/or polishing is also described. The glove-box laboratory and equipment are discussed in relation to specimen preparation technique and BeO toxicity. Transmitted light examinations indicate that unpolished as well as polished sections are a valuable aid to reflected light examinations. The thin sections studied ranged from 0.020 to 0.002 in. in thickness. (auth)

9237 (GEMP-61, pp 177-84) HIGH-TEMPERATURE RESEARCH ON CARBIDES FOR FUEL AND STRUCTURAL APPLICATIONS. White, J. F.; Juenke, E. F. (General Electric Co., Cincinnati, Ohio. Nuclear Materials and Propulsion Operation).

Reaction products resulting from heating Re and UC at 2000°C were subjected to electron-probe analysis. Details of interface reactions are discussed. Apparatus and techniques for preparing single-phase UC are described. Carbon activity, as a function of composition in the UC region, was determined by the gas-solid equilibration techniques using Re capsules. (P.G.C.)

9238 STRUCTURE OF TANTALUM OXIDES. Terao, Nobuzo (Union Carbide European Research Associates, Brussels). Jap. J. Appl. Phys., 6: 21-34(Jan. 1967). (In French).

The structure change of tantalum on heating in air and oxygen was followed by x-ray diffraction. Numerous forms of Ta oxides have been identified. Ta-(O) (solid solution), TaO_y, TaO_z, δ-form and β-Ta_2O_5 are formed in air at either atmospheric or reduced pressure. The nitrogen in the air is believed to be important for high temperature oxidation of tantalum since nitrides such as Ta_2N and δ-TaN were observed. Heating of Ta powder in oxygen causes violent ignition and the α-form which has hitherto been considered to be a high-temperature form of Ta_2O_5 is obtained. The transformation $\alpha \rightarrow \beta$ occurs on heating in oxygen and the inverse transformation $\beta \rightarrow \alpha$ occurs on heating in vacuum at a temperature higher than 1300°C. The helium method of density measurement showed that the α-form is an oxide lower than Ta_2O_5. In the products of thermite reactions of (Ta + CuO) system, the dioxide TaO_2 and a new cubic form of Ta oxide were observed. (auth)

9239 THEORY OF GRAIN GROWTH IN POROUS COMPACTS. Nichols, F. A. (Bettis Atomic Power Lab., Pittsburgh). J. Appl. Phys., 37: 4599-4602(Dec. 1966). (WAPD-T-1924).

The theory of grain growth in porous compacts controlled by the migration of pores with the boundaries is developed for all possible transport processes. It is shown that the cubic rate law reported for both UO_2 and Al_2O_3 compacts, if it is due to pore migration, must be interpreted as being controlled by vapor transport through the pore with the pressure maintained at $2\gamma/r$, where γ is the surface tension and r the pore radius. Available data for UO_2 and Al_2O_3 are analyzed according to this model and found to give satisfactory agreement, with the calculated activation energies being reasonably close to the heats of vaporization for the two oxides. An interesting prediction of the model is that the compact should in fact show a decrease in density during grain growth. This behavior has been observed in the case of UO_2 but apparently has not yet been reported for Al_2O_3. (auth)

9240 THE OXIDES OF PROTACTINIUM. Roberts, L. E. J.; Walter, A. J. (Atomic Energy Research Establishment, Harwell, Eng.). pp 51-9 of Physico-Chimie du Protactinium. Paris, Centre National de la Recherche Scientifique, 1966.

The x-ray diffraction patterns, densities and compositions of the phases in the Pa-O system which are stable at room temperature were determined. The phases identified are: $PaO_{2.00}$, fcc (C1); $PaO_{2.17}$-$PaO_{2.20}$, fcc (C2); $PaO_{2.33}$, tetragonal (T1); $PaO_{2.40}$-$PaO_{2.42}$, tetragonal (T2); $PaO_{2.42}$-$PaO_{2.44}$, rhombohedral (R1); and Pa_2O_5, tetragonal (T3). All these structures are based on the fluorite structure, with an ordered arrangement of oxygen on interstitial sites. Two other structures of Pa_2O_5 are formed at temperatures above 1,000°C; one is hexagonal (H) and one rhombohedral (R2); these are probably also closely related to the fluorite structure. PaO_2 forms a complete range of solid solutions with ThO_2, and these solid solutions can be oxidized with additional oxygen entering interstitial sites. (auth)

9241 ELECTRON DIFFRACTION DETERMINATION OF THE IONIZATION OF THE CARBON ATOM IN β-Mo_2C CRYSTAL. Nagakura, Sigemaro; Kikuchi, Makoto; Oketani, Shigueo (Tokyo Inst. of Tech.). Acta Crystallogr., 21: 1009-10(Dec. 10, 1966).

Studies on the state of atomic ionization in crystals showed that electron diffraction is favorable for analysis of transition metal carbides, such as β-Mo_2C, which gives superstructure reflections. The results of the analysis, which are discussed, led to the conclusion that the carbon atom is almost in the state of C^{1-}. (P.C.H.)

9242 DIFFUSION OF CARBON IN THE CARBIDE PHASE OF TANTALUM. Fromm, Eckehard; Gebhardt, Erich; Roy, Upendra (Max-Planck-Institut fuer Metallforschung, Stuttgart). Z. Metallk., 57: 808-11(Nov. 1966). (In German).

The diffusion constant of C in the TaC and the Ta_2C phase was determined from the growth rate of carbide layers formed on Ta surfaces. Taking into account the mutual influence of the layer growth during the formation of two-phase carbide layers, diffusion constants of C in the TaC and Ta_2C phases were determined separately. For the activation energy of diffusion of C in the TaC and Ta_2C phases, values of 98 and 85 kcal/mol, respectively, were obtained at 2215 to 2745°C. (auth)

9243 NONEXISTENCE OF YTTRIUM ZIRCONATE. Smith, D. K. (Univ. of California, Livermore). J. Amer. Ceram. Soc., 49: 625-6(Nov. 21, 1966).

Neutron diffraction data are presented for the system $Y_2O_3-ZrO_2$. The data refute previous arguments for existence of the compound $Y_2O_3 \cdot 2ZrO_2$ in the system. (P.C.H.)

9244 EFFECT OF INCLUSIONS ON GRAIN GROWTH OF OXIDES. Arias, Alan (Lewis Research Center, Cleveland). J. Amer. Ceram. Soc., 49: 621-4(Nov. 21, 1966).

Effects of 10 vol % Cr, Mo, W, Mn, Ni, Ti, BN, and ZrB_2 on the grain growth of Al_2O_3, HfO_2, MgO, and ZrO_2 were investigated by vacuum heat-treating previously vacuum hot-pressed specimens containing a layer of the cermet and a layer of the corresponding oxide. Most of the metals and compounds inhibit grain growth of the four oxides investigated. Some of the additions enhance grain growth, whereas others react with the matrix oxide. In most systems, the oxide layer adjacent to the cermet showed exaggerated grain growth at the interface. No correlation was found between reactivity, melting point, and volatility of the metal addition and grain growth of the matrix oxide. (auth)

9245 REACTION OF SOME NOBLE AND TRANSITION METALS WITH REFRACTORY CARBIDES. Krikorian, N. H.; Wallace, T. C.; Krupka, M. C.; Radosevich, C. L. (Los Alamos Scientific Lab., N. Mex.). J. Nucl. Mater., 21: 236-8(Feb. 1967). (LA-DC-8216).

Reactions of UC with Ir and Rh, UN with Au, UC and ThC with Au, and TaC with Re are discussed. (M.C.G.)

9246 CONCERNING THE TERNARY DIAGRAM URANIUM-CARBON-OXYGEN. Blum, P.-L.; Morlevat, J.-P. (Centre d'Etudes Nucleaires, Grenoble, France). Rev. Int. Hautes Temp. Refract., 3: 253-4(July-Sept. 1966). (In French).

The partial diagram limited by the U, uranium dioxide, and uranium monocarbide phases is presented. Three aspects of the complete diagram resulting from these investigations are shown. The first aspect shows the liquidus formed of three deposit sheets: U, UO_2, and U(C,O). The second aspect shows the regions that appear after removal of the three liquidus surfaces. The third aspect gives a view of the solidus. (J.S.R.)

9247 INVESTIGATIONS ON THE SYSTEM URANIUM-OXYGEN-CARBON. Heiss, A.; Dode, M. (Faculte des Sciences, Orsay, France). Rev. Int. Hautes Temp. Refract., 3: 245-51 (July-Sept. 1966). (In French).

Development of a graphite resistance furnace for thermodynamic studies at high temperatures and pressures and of a resistance furnace using Ir and Pt-Rh alloys was reported. The furnaces were used for study of the U-O-C system. The first and second monovalent equilibria were studied. Results are discussed in detail. (J.S.R.)

Radiation Effects

Refer also to abstracts 9234, 10214, and 10221.

9248 (CEA-R-3066) RESULTATS D'IRRADIATION D'ELEMENTS COMBUSTIBLES EN OXYDE MIXTE UO_2–PuO_2. (Results of the Irradiation of Mixed UO_2–PuO_2 Oxide Fuel Elements). Mikailoff, Hubert; Mustelier, Jean-Pierre; Bloch, Jacqueline; Ezran, Leon; Hayet, Lucien (Commissariat a l'Energie Atomique, Fonetnay-aux-Roses (France). Centre d'Etudes Nucleaires). Sept. 1966. 92p. (In French). Dep. mn.

Results of irradiation on stainless steel-clad fuel rods of UO_2–PuO_2 are reported. Details of stability, thermal performance, release of fission gases, and action of Na on the fuel assembly are presented. It was found that Na, entering through cracks in the casing, caused release of fission gases, followed by intergranular disintegration of the rim of the fuel element, plugging of the fission gas escape route, and deformation of the fuel rods. (P.G.C.)

9249 (GEMP-61, pp 157-70) RADIATION EFFECTS IN BeO. Collins, C. G. (General Electric Co., Cincinnati, Ohio. Nuclear Materials and Propulsion Operation).

Effects of irradiation on physical properties and microstructure of BeO are summarized. Diffusivity of irradiated BeO, in absence of microcracking, decreases up to about 58% at 300°C and up to about 21% at 1000°C with significant changes for different irradiation temperatures. (P.G.C.)

9250 (RFP-658, pp 38-42) POST-IRRADIATION METALLOGRAPHIC EXAMINATION OF ARC-CAST HYPOSTOICHIOMETRIC URANIUM MONOCARBIDE. Arnold, J. L. (Atomics International, Canoga Park, Calif.).

A metallographic examination of UC fuel from a series of irradiation experiments was performed. Hypostoichiometric UC fuel samples that had operated at 1600 to 2500°C for a short period of time had a structure which included large voids and metallic U in the grain boundaries, as well as numerous fine voids within each UC grain. In addition, the material adjacent to certain grain boundaries appeared relatively free of voids. These grain boundaries were located on the side of the grains nearest the axial center line of the samples. This feature of the microstructure of the UC is attributed to a grain boundary sweeping action as the grain boundaries migrated toward the center of the sample under the influence of the temperature gradient. Similar features were not found in samples that were irradiated at centerline temperatures of 850 to 1000°C. (auth)

9251 (RT-FI-(66)-18) EXPERIMENTS ON THE URANIUM EMISSION FROM SINTERED URANIUM OXIDE PELLETS. Ferrari, S.; Segre, G. J. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). 1966. 25p. Dep. mn.

Data are given on atomic U emission from irradiated sintered UO_2 fuel pellets. Explanations to account for the phenomena of emission from U and re-emission from Al-foil absorbers are postulated. (P.G.C.)

9252 (SC-R-66-923) TRANSIENT ANNEALING IN SEMICONDUCTOR DEVICES FOLLOWING PULSED NEUTRON IRRADIATION. Sander, H. H.; Gregory, B. L. (Sandia Corp., Albuquerque, N. Mex.). Nov. 1966. Contract AT(29-1)-789. 27p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Transient annealing following pulsed neutron exposure was investigated in Si transistors and solar cells as a function of both irradiation temperature and injection level. Experiments incorporating x radiation and gamma rays demonstrated that transient annealing is a bulk, not a surface, effect. The observed annealing following neutron irradiation is considerably slower at low temperatures than at room temperature. At 213°K the density of annealable defects remaining at 10^{-4} sec after exposure is approximately three times that observed at this same time for a 300°K irradiation. The injection studies show that at any temperature from 76 to 300°K the presence of minority carrier injection considerably speeds the transient annealing processes. A model is presented which explains many of the features observed in transient annealing. Various kinetic processes are discussed in the derivation of this model, including diffusion-limited and generation-limited processes, and the results of the model are compared with experimental data. (auth)

9253 MECHANICAL PROPERTIES OF NEUTRON-IRRADIATED PYROLYTIC CARBONS. Price, R. J.; Bokros, J. C. (General Atomic Div., General Dynamics Corp., San Diego, Calif.). J. Nucl. Mater., 21: 158-74(Feb. 1967). (GA-6926).

A variety of pyrolytic carbons with laminar, isotropic, or granular microstructures, deposited from methane in a fluidized bed between 1400 and 2000°C, were irradiated with fast neutrons at 540 to 1060°C to exposures of 1.5 to 2.4×10^{21} nvt (E > 0.18 MeV). The elastic modulus, flexural strength, and fracture strain were determined for unirradiated and irradiated samples. Irradiation creep behavior was studied by measuring the strain in composite samples consisting of pyrolytic C and polycrystalline graphite in which the differential neutron-induced contraction caused the C to be strained in tension during irradiation. Irradiation increased the elastic moduli of the carbons by 30% to 100%, the increases being greatest in the isotropic and granular carbons with low initial moduli. The flexural strength of the laminar carbons was not changed by irradiation, but that of the isotropic and granular carbons increased by up to 60%. The creep specimens of granular and high-density isotropic carbons withstood tensile creep strains of up to 3.3% without cracking. The steady-state creep constant was of the order of $\sim 1 \times 10^{-7}$ $(psi)^{-1} \cdot (10^{20}$ nvt$)^{-1}$. (auth)

9254 A RELATION BETWEEN IRRADIATION TEMPERATURE, FLUX INTENSITY, AND START-TEMPERATURE FOR STORED ENERGY RELEASE IN IRRADIATED GRAPHITE. Bridge, H. (Univ. Research Reactor, Risley, Eng.); Mottershead, D. J. Nucl. Mater., 20: 281-6(Sept. 1966).

In graphite that has been subjected to fast-neutron bombardment, the temperature at which the release of stored energy commences during thermal annealing at a linear rate of rise of temperature with time, the start temperature is of both theoretical and of practical interest. Consideration of defects just stable under the irradiation conditions in terms of Vand annealing kinetics enables a temperature representing the onset of the energy release to be calculated with sufficient precision for use in practical applications. (auth)

9255 ANNEALING STUDY IN ELECTRON-IRRADIATED n-TYPE SILICON. Tauke, Regina V.; Faraday, Bruce J. (Naval Research Lab., Washington, D. C.). J. Appl. Phys., 37: 5009-11(Dec. 1966).

The annealing of defects introduced by room-temperature irradiation as manifested by changes in the impurity band optical absorption α_I and in the minority carrier lifetime τ is reported for pulled (high O_2 content) and for float-zone (low O_2 content) n-type P-doped Si. Conductivity changes induced in n-type Si crystals by 1-MeV electrons are discussed and the characteristics of the reverse-annealing stage with the behavior of α_I and τ are compared. The extension of conductivity annealing data to 600°C is reported. (M.O.W.)

Plastics and Other Materials

Refer also to abstracts 9050, 9189, 9662, and 10178.

9256 (AD-642301) RADIATION EFFECTS ON (MONOLITHIC) MICROELECTRONIC CIRCUITS. Final Report, May 1, 1965–July 31, 1966. Report No. 5. Perkins, C. W.; Marshall, R. W.; Liebschutz, A. M. (Hughes Aircraft Co., Fullerton, Calif.). Nov. 1966. Contract DA 28-043 AMC-01313(E). 81p. (ECOM-01313(F)).

Evaluation of commercial circuits reveals that the better constructed circuits are immune to transient radiation disturbances up to 10^9 rads (Si)/sec and to permanent damage up to at least 10^{13} $N_f$vt. Analysis shows that the transient effects originate in the junctions with the substrate. Theoretical expressions are derived for the critical radiation thresholds. On the basis of this analysis, guidelines are set down for the design of monolithic circuits resistant to transient radiation effects. Analysis shows that permanent damage is due to degradation of transistor current gain. Theoretical expressions are derived for the critical radiation thresholds for permanent damage. On the basis of this analysis, guidelines are set down for the design of radiation-hardened monolithic circuits. (auth)

9257 (NASA-CR-656) CHARGE STORAGE EFFECTS IN MYLAR RESULTING FROM ELECTRON IRRADIATION. Monteith, L. K.; Hauser, J. R.; Royal, T. M. (Research Triangle Inst., Durham, N. C.). Dec. 1966. Contract NAS 1-5225. 95p. CFSTI $3.00 cy, $0.65 mn.

External charge transfer resulting from electron irradiation of mylar was observed and a phenomenological model developed which includes space charge build-up, transport of charge during irradiation, and the decay of space charge after ceasing irradiation. The spatial symmetry does not strongly influence the external charge transfer characteristics. Charge storage resulting from electron irradiation of capacitor structures using mylar can result in spontaneous discharge events. At flux rates comparable to those of the Van Allen belt, irregular discharge events with a pulse height less than 1 volt were observed. For flux rates in excess of 10^{12} e/cm^2-sec regular pulsing with a pulse height the order of 100 volts was observed. These can be interpreted as partial and complete liberation of the trapped charge respectively. (auth)

9258 (UCRL-50125) CREEP BEHAVIOR OF POLYSTYRENE BEAD FOAM UNDER UNIAXIAL COMPRESSION. Zaslawsky, Maurice (California Univ., Livermore. Lawrence Radiation Lab.). Aug. 19, 1966. Contract W-7405-eng-48. 49p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The creep behavior of polystyrene bead foam under uniaxial compression was studied in a series of tests. Density of the test specimens ranged from 0.0256 to 0.0534 g/cc, applied stress from 2 to 18 psi, and temperature from 23 to 78°C. With stress and temperature held constant, creep tests were performed for periods ranging from 5 sec to 100 hr. Recovery of some of the specimens after removal of the stress load was measured for an additional 25 hr. Effects of both steady and cyclic stress were studied. Foam density appears to be the most important factor influencing creep rate, while specimen dimensions and surface preparation appear to have little effect. (auth)

9259 SOME IMPORTANT FACTORS IN THE RADIATION TREATMENT OF NATURAL RUBBER LATEX. Lamm, A.; Lamm, G. (Center of Nuclear Research, Saclay, France. Lab. of Rubber Control and Research, Paris). pp 139-47 of Applications des Rayonnements en France. Vol. I. Gif-sur-Yvette, France, Centre d'Etudes Nucleaires de Saclay, 1966.

It was shown previously that γ irradiation of natural rubber latex and of aqueous carbon black dispersions followed by mixing of the irradiated products and by their drying yields excellent rubbers. Various factors that could affect the properties of rubber obtained by this technique were investigated. The effect of chloroform on the mechanical properties of latex reinforced by carbon black was studied, and it was shown that the dose for maximum tensile strength is diminished of a factor of about 10 when the chloroform is present. Black latex films prepared without sensitizer from irradiated latex and carbon black were aged in an accelerated test. The aging properties of the irradiated films were excellent. A study of the electric conductivity showed that irradiation of the carbon black caused an increase in the conductivity and that irradiation of the latex caused a drastic increase in the conductivity. The use of colloidal silica as a reinforcement agent in irradiated latex was studied and compared with the results of conventional vulcanization. It was established that the tensile strength and modulus of the radiation-treated films were lower than those of a sulfur-vulcanized film, but the elongation and tear strength were higher. (J.S.R.)

9260 EFFECT OF HIGH ENERGY RADIATIONS ON INSULATORS. Coelho, Roland. pp 227-8 of Applications des Rayonnements en France. Vol. I. Gif-sur-Yvette, France, Centre d'Etudes Nucleaires de Saclay, 1966. (In French).

The effect of high-energy radiation on the conductivity of polyethylene was investigated on samples irradiated in air and in N_2. In both cases the conductivity began to increase with the dose received and only began to decrease for doses above several MR. In studies on the hardness and elongation at rupture it was shown that for samples irradiated in air the length of irradiation seemed to be a more important parameter than the total absorbed dose. Studies were also made on the nature of the charge carriers by studying the natural conductivity and the conductivity induced by a low x-ray flux on samples having absorbed increasing doses up to 200 MR. The variation of the induced current with radiation intensity showed that in the interval from 180 to 4,300 R/hr the induced current i varied with the intensity I according to the law $i \sim J^{\Delta}$. The Δ exponent decreased with dose absorbed to a minimum at a dose of the order of a megarad. The induced conductivity and the natural conductivity varied in a similar fashion with the dose absorbed. Some of the experimental results can be interpreted within the framework of the Rose model based on the theory of bands and suggests an electronic conductivity of type p. (J.S.R.)

PHYSICS (GENERAL)

Astrophysics

Refer also to abstracts 9673, 9729, 9759, and 9767.

9261 (N-66-32564) EFFECT OF ULTRAVIOLET RADIATION ON THE IONIZATION AND EXCITATION OF MATTER IN PROMINENCES. II. CONTINUOUS SPECTRA. Kawaguchi, Ichiro (Kyoto Univ. (Japan)). 1965. 16p. CFSTI $3.00 cy, $0.65 mn.

Given the electron density, temperature, and the intensities of Lyman continuous and Lyman alpha radiation incident upon prominences, the ionization of hydrogen atoms and the excitation of the second energy level are obtained as a function of optical depth. Using a simplified model in which a prominence is stratified into two zones, it is shown that the observed Balmer and Paschen jump can be explained in terms of a low temperature 6000° ~ 8000°K and an electron density $N_e = 5.10^{10}$ cm^{-3}. Based on the observed brightness, a possible structure of prominences is discussed. (auth)

9262 (NASA-TM-X-57737) PUBLICATIONS OF GODDARD SPACE FLIGHT CENTER, 1963. VOLUME I. SPACE SCIENCES. (National Aeronautics and Space Administration, Greenbelt, Md. Goddard Space Flight Center). 1556p.

Includes Reports, N-66-32006 through N-66-32043.

Articles, papers, talks, and reports generated by the scientific and engineering staff of the Goddard Space Flight Center in the year of 1963 are collected. The publications are grouped into the following broad subject categories: astronomy and astrophysics, celestial mechanics and geodesy, solar physics, ionosphere and radio physics, fields and particles, planetology, and planetary atmospheres. An overall author index is included. (J.H.M.)

9263 (BNL-tr-118) NUCLEAR SPECTROSCOPY AND SOLAR NEUTRINO ASTROPHYSICS. Kocharov, G. E.; Starbunov, Yu. N. Translated by S. J. Amoretty (Brookhaven National Lab., Upton, N. Y.), from Izv. Akad. Nauk, SSSR, Ser. Fiz., 30: 1090-4(1966). 14p. Dep. mn. CFSTI $3.00 cy, $0.65 mn. JCL $1.60 fs, $0.80 mf.

The detection of solar neutrinos will give an experimental conformation of the hypothesis of the thermonuclear origin of stellar energy and determine the temperature in the core of the sun. It is shown that the accuracy in determining the temperature in the sun's interior chiefly depends on the excited state characteristics of a number of nuclei and on the magnitude of certain nuclear reaction cross sections in the super-low energy region. (W.D.M.)

9264 ANALYSIS OF THE SPECTRA OF BOV STARS τ SCORPII. Scholz, M. Z. Astrophys., 65: 1-29(1967). (In German).

The spectrum of the BOV star τ Sco is analyzed by means of model atmospheres (LTE, no blanketing effect). The observations are well reproduced by the model parameters: $T_{eff} = 32{,}800°K$, $\log g = 4.2$, microturbulence $\xi(\tau) \equiv 5$ km/sec. The abundances of 11 elements are given. $N_{He}/N_H = 0.12-0.13$ was found for helium, using only weak HeI lines. (auth)

9265 SYNCHROTRON RADIATION AND VARIATION OF ELECTRON ENERGY SPECTRA. Hirth, W. (Univ., Bonn). Z. Astrophys., 65: 48-59(1967). (In German).

The time variation of electron energy spectra caused by synchrotron radiation losses is investigated. Several solutions for the equation of balance are discussed in connection with observed spectra of radio galaxies. A simple method dealing with the initial value problem is given. The fact that most spectral indices are about 0.7 in spite of different age of the galaxies is explained by assuming similar starting conditions. The similar cutoff frequencies observed in certain radio spectra (class S_2) can be interpreted by assuming a slow decrease of the magnetic energy density in these radio sources. (auth)

9266 THERMOLUMINESCENCE OF THE MOON. Sun, K. H.; Gonzalez, J. L. (Westinghouse Electric Corp., Pittsburgh). Nature, 212: 23-5(Oct. 1, 1966).

Available evidence indicates that the phenomenon of lunar luminescence is related to the bombardment of meteoritic dust (enstatite achondrites) existing on the surface of the moon by solar protons and electrons. It is postulated that the dust particles absorb and store energy from the solar wind protons during the lunar night and release it in the form of thermoluminescence upon heating at the terminator. In support of this theory, an experiment is described in which enstatite achondrites were irradiated at liquid nitrogen temperature with 2 MeV electrons and the luminescence was measured as a function of temperature as the samples were heated. (W.D.M.)

9267 INFRARED OBSERVATIONS OF A PREPLANETARY SYSTEM. Low, Frank J.; Smith, Bruce J. (Rice Univ., Houston, Tex. Univ. of Arizona, Tucson). Nature, 212: 675-6(Nov. 12, 1966).

R Monocerotis, the twelfth-magnitude object at the head of Hubble's variable Nebula, is classified as a T Tauri variable—a type of star thought to be in the latter stages of contraction. Extending Mendoza's infrared observations which showed an unexpectedly large infrared excess for R Monocerotis to a wavelength of 20μ, excellent agreement was found with a model in which thick circumstellar dust absorbs and re-radiates the energy produced by a luminous central object. The high luminosity is consistent with the idea that R Monocerotis is a protostar still undergoing contraction. If this is the case, both the energy released in contraction and most of the angular momentum are being transferred to an extended envelope of dust which will ultimately form a planetary system around the star. (W.D.M.)

9268 SMALL DIAMETER COMPONENTS IN THE CRAB NEBULA AT 1,422 Mc/s. Kronberg, P. P. (Nuffield Radio Astronomy Labs., Cheshire, Eng.). Nature, 212: 1557-8(Dec. 31, 1966).

Recent observations of the Crab Nebula using the Jodrell Bank Mark I-Mark II interferometer at 1422 Mc are reported. By tracking at many hour angles the fringe amplitude and phase were measured at a number of projected baselines up to 2000 λ. At projected spacings greater than about 800 λ the large scale structure is completely resolved, so that at these baselines the fringe visibilities represent only the small-scale components. Each antenna responded to right-hand circular polarization. (W.D.M.)

9269 DENSITY EVOLUTION HYPOTHESIS FOR QUASARS. Rowan-Robinson, M. (Univ. of Sussex, Eng.). Nature, 212: 1556-7(Dec. 31, 1966).

Assuming that the red shifts of quasars are cosmological, it has been suggested that the present available distribution of flux densities at 178 Mc of quasars against red shift implies that the radio luminosity of quasars which exist at cosmic epoch, t, is a decreasing function of t. It is concluded that although it is not possible, in various cosmological models, to test between the luminosity and density evolution hypotheses for quasars by means of identifications in the 3C catalogue, a sufficiently large number of measured red shifts in the 4C catalogue should make it possible to test between these hypotheses. (W.D.M.)

9270 EMPIRICAL MODELS OF STELLAR ATMOSPHERES. III. COMPARISON OF DIFFERENT MODELS FOR SUNSPOTS. van't Veer, Frans (Institut d'Astrophysique, Paris). Ann. Astrophys., 29: 223-30(May-June 1966). (In French).

An application of an empirical model for certain stellar atmospheres is applied to the Mt. Wilson sunspot No. 11730. The temperature, mean gradient of temperature, electron pressure, and mean gradient of electron pressure are determined; the curvature of gradients toward the surface is not determined. The model is compared with those of previous workers, particularly that of Zwaan and that of Fricke and Elsaesser. Agreement is found for gas pressure and for the gradient of gas pressure, and the new model shows that previous assumptions about the gradient of gas pressure were valid. The temperature gradient differs between Zwaan and the present work. Errors based on uncertainly valid assumptions about the profile of Balmer lines are suggested, and offer a source of distinction between earlier and present results. The method permits fitting of data to the model but also suggests to what extent the model is the sole one to fit the data. (BBB)

9271 SOME THEORETICAL AND EXPERIMENTAL ASPECTS OF SOLAR BRIGHTNESS IN THE MIDDLE AND SUB-MILLIMETER INFRARED. Lena, P. (Faculte des Sciences, Orsay, France). Ann. Astrophys., 29: 361-3(July-Aug. 1966). (In French).

The variation of brightness from center to limb is calculated from available models of solar atmospheres, with attention focused on the region from 8 to 700 μ. These are compared with existing measurements, and the connection with the millimeter range is discussed. Data are drawn from the models of Meudon, Utrecht, and HAO; the data of Saiedy are used as experimental values for comparison. Several figures plot relative brilliance at 10 μ, 16 μ, 20 μ, 30 μ, 46 μ, 100 μ, 350 μ, and 600 μ. The chromospheric level where radiation between 100 and 700 μ predomi-

nates is calculated as a function of wavelength. Experimental needs for new measurements are outlined. (BBB)

9272 SOLAR PROTON ACTIVATION OF THE LUNAR SURFACE. Ebeoglu, D. B.; Wainio, K. M. (Bendix Systems Div., Bendix Corp., Ann Arbor, Mich.). J. Geophys. Res., 71: 5863-72(Dec. 15, 1966).

The nuclear activation on the surface of the moon due to solar protons is estimated. Proton and neutron fluxes and the production rate of radionuclides are calculated as a function of depth, and comparisons are made between several models of the lunar crust. The purpose of the calculations was to evaluate the effectiveness of lunar material as a radiation shield and also to predict the particle flux reflected from the surface. The buildup of ^{54}Mn, ^{22}Na, ^{14}C, and ^{7}Be are given in compositions representing both the volcanic and meteoritic-impact hypotheses for the lunar surface. The effect of the angular distribution of the protons on the radionuclide production rate and particle fluxes was also investigated. Examples involving a monoenergetic beam of 400-MeV protons as well as a solar proton spectrum are included, permitting direct comparisons with experimental irradiations of similar targets. The results show that the activation is strongly dependent on the spectrum and angular distribution of incident protons but relatively insensitive to the composition. (auth)

9273 PROTON FLARES AND TYPES OF SPOT GROUPS IN THE 11-YEAR CYCLE. Kopecky, M.; Krivsky, L. (Astronomical Inst., Czechoslovak Academy of Sciences, Ondrejov). Bull. Astron. Inst. Czech., 17: 360-5(1966).

Investigated is the relation of the occurrence of proton flares (with particle emissions and radio outburst IV) in time-latitude distribution together with the maximum development type of spot groups and the configuration of absolute isophotes of corona 5303 Å in the 11-year cycle of solar activity between 1954 and 1964. Further investigated is the frequency with which proton flares occur in the active regions of the individual spot-group types. Such flares are most frequent in types E, F, and H. The ratio of the occurrences of proton flares to the existence of a spot group per 1 day differs largely in the period of the ascending phase of the cycle in comparison with the descending phase: such flares per 1 day of the existence of groups were more frequent by 50% from 1959 to 1963 than from 1956 to 1958. This supports M. N. Gnevyšev's views of a larger specific importance of the phenomena during the second pulse of activity. The frequency distribution of the maximum types of spots in the time-latitude graph, however, does not agree for types E, F, G, H too well with the configuration of the isophote field of corona 5303 Å, nor with the frequency distribution of proton flares. On the other hand, there is a good agreement between the frequency distribution of small spot groups of the maximum types A, B, C and the corona and flares as well. It is evident that a marked frequency of small groups in a certain latitude zone on the Sun is the governing factor which produces during the occurrence of the large types E and F, and in combination with them, a situation in the atmospheric layers of the Sun that gives rise to proton flares. Some of the results may be applied for proton flare forecasts. (auth)

9274 A NOTE ON TUOMINEN'S MODIFICATION OF BABCOCK'S THEORY OF THE SOLAR MAGNETIC FIELD. Vostry, J. (Charles Univ., Prague). Bull. Astron. Inst. Czech., 17: 366-9(1966).

In Babcock's model of solar activity, the initial magnetic field is given by the form $H_\varphi^0 = H_0^0 \sec \varphi$ on the solar surface. This field has singularities at the solar poles. In accordance with Spörer's law, which was derived from this field, the sunspot activity begins at the heliographic latitude $\varphi = 45°$. This value is too high to agree with observations. Tuominen suggested to apply magnetic fields $H_\varphi^0 = H_0^0$ and $H_\varphi^0 = H_0^0 \cos \varphi$, which overcomes these difficulties. Derived is Spörer's law for these two cases, derived for them is also Gleissberg's law of migration in the heliographic latitude of the sunspot area. On the basis of this law it is shown that these two magnetic fields give no correct description of either the average velocity of migration in the heliographic latitude of the sunspot area i.e., the average curve of the butterfly diagram, or the velocity of migration in the heliographic latitude of the area in which the sunspot activity begins i.e., the left-hand and lower border of the butterfly diagram. (auth)

9275 VARIATIONS OF THE SOLAR ACTIVITY AND THE PRODUCTION OF ^{14}C BY COSMIC RAYS. Link, F. (Institut Astronomique, Prague). Bull. Cl. Sci., Acad. Roy. Belg. (5), 52: 486-9(1966). (In French).

The curves of aurora numbers $\Delta \log \underline{c}$ observed per year as a function of the date and of the variations of the ^{14}C produced per year were compared. There is a negative correlation between the two series. (J.S.R.)

9276 THE OI TRIPLET AT 7772 A IN THE B3-A0 STARS OF THE PRINCIPAL SEQUENCE. I. THEORETICAL INTENSITIES AND PROFILES. Houziaux, Leo (Univ., Liege). Bull. Cl. Sci., Acad. Roy. Belg. (5), 52: 202-28(1966). (In French).

The theoretical intensities and profiles obtained with the aid of four atmospheric models are given. The principal conclusions to be drawn from the calculations are the following: For the oxygen abundances usually considered ($A \cong 10^{-3}$), the triplet rays at λ7772 are found in the intermediary portion of the growth curve. The equivalent lengths vary from 0.1 to 0.5 Å. The triplet rays can with difficulty permit a precise determination of the oxygen abundance. An axial rotation of moderate velocity (≅ 50 km/sec) is sufficient to make it difficult to observe the rays. The introduction of a microturbulence velocity contributes to the intensification of the rays in a much more efficient manner than an increase of the oxygen quantity. Moreover, the microturbulence has the effect of decreasing the saturation effects at the center of the rays. (tr-auth)

9277 ABSOLUTE MAGNITUDES OF QUASI-STELLAR RADIO SOURCES. McVittie, G. C.; Stabell, R. (Univ. of Illinois, Urbana). Nature, 213: 133-5(Jan. 14, 1967).

Some recent investigations have been concerned with the relation between the red shift and the optical apparent magnitudes or the observed radio flux densities of quasi-stellar radio sources. The object of the present communication is to analyse the absolute magnitudes of a number of such sources for which the red shifts and the visual apparent magnitudes are available. It was found that the absolute magnitudes plotted against the logarithms of the red shifts fall between two limits. Interpretation of the curves varies according to the type of model universe chosen, and caution suggests that a variety of models should be investigated before final conclusions are drawn. The results throw some light on the origin of quasi-stellar sources. (UK)

9278 RELATION BETWEEN OPTICAL AND RADIO PROPERTIES OF QUASARS. Verschuut, G. L. (Manchester Univ., Eng.). Nature, 213: 164(Jan. 14, 1967).

The purpose of this communication is to point out some interesting relationships between colours of quasars and their radio polarization properties. Among these are the following—objects which are most highly polarized are those with relatively large uv excess, while redder objects are unpolarized at 20cm. Redder objects also have the largest radio rotation measures. This could be an evolutionary effect. Initially the source consists mainly of synchrotron electrons emitting polarized radiation, but as it evolves an increasing number of these electrons decay to thermal velocities, producing an increase in the observed rotation measures. The associated decrease in polarization could be due to differential Faraday rotation, combined with a possible increase in the tangled nature of the magnetic field structure within the source. When a significant fraction of the synchrotron electrons has been thermalized the effect on the spectrum of the source might be detectable. A considerable part of the rotation measures may well be intrinsic to the sources and hence cannot be used to make any precise models of the galactic magnetic field. (UK)

9279 DETERMINATION OF THE CONSTANCE OF THE COSMIC RADIATIONS AND OF THE TERRESTRIAL AND COSMIC AGES OF FERROUS METEORITES BY THE RADIOACTIVITY OF ^{26}Al AND ^{10}Be. Crevecoeur, E. (Univ., Louvain, Heverle, Belg.). Bull. Cl. Sci., Acad. Roy. Belg. (5), 52: 261-75(1966). (In French).

A study was made of the intensity of cosmic radiation in the past and the cosmic and terrestrial ages of ferrous meteorites were determined from a determination of their content in ^{26}Al and ^{10}Be. The activities of the radioisotopes were measured from thin films of the oxides. A rigid chemical separation of the elements was necessary to avoid errors caused by radioactive impurities. The results of the measurements are tabulated. The intensity of cosmic radiation was calculated as a constant for the past 5 million years. An appendix gives the properties of the meteorites studied. (J.S.R.)

9280 SPECTRAL DENSITY OF THE POSSIBILITY RANDOM FLUCTUATIONS OF 3C 273. Manwell, Tom; Simon, Michal (Cornell-Sydney Univ. Astronomy Center, Ithaca, N. Y.). Nature, 212: 1224-5(Dec. 10, 1966).

The averaged luminosities of Ozernoi and Chertoprud were used to calculate the spectral density for 3C 273. The spectral density was calculated by the method of Blackman and Tukey and Parzen. The spectral density of the 3C 273 fluctuations is shown as a function of the frequency measured in yr^{-1}. No attempt was made to normalize the spectral density and therefore only relative amplitudes are significant. It is evident that there is a large peak in the spectral density at the frequency of 0.08 yr^{-1}, which could be interpreted as indicating a period of 12.5 yr. (W.D.M.)

9281 SOME RESTRICTIONS ON MODELS OF QUASI-STELLAR OBJECTS. Hoyle, F. (Cambridge Univ., Eng.); Burbidge, G. R. Nature, 212: 1223-4(Dec. 10, 1966).

Various restrictions on models of quasars are discussed and it is concluded that a model involving the presence of large amounts of relativistically moving matter is required if the quasars lie at cosmological distances. It is noted that such a system of blobs flying apart would correspond to the kind of process that one must invoke for the origin of the quasars on the local hypothesis. (W.D.M.)

9282 GALACTIC DEPOLARIZATION OF THE 21-CENTIMETER-WAVELENGTH RADIATION OF EXTRAGALACTIC SOURCES. Bologna, J. M.; McClain, E. F.; Sloanaker, R. M. (Naval Research Lab., Washington, D. C.). Science, 154: 1656-8(Dec. 30, 1966).

The dependence of the degree of linear polarization of the radiation from 213 extragalactic sources on galactic coordinates was investigated at 21-cm wavelength. In addition to the previously known latitude effect, the depolarization of the radiation during transit through our galaxy is also a function of galactic longitude. One possible explanation is that galactic depolarization is a simple function of the distance traveled by the radiation through an extended galactic halo. (auth)

9283 ABSORPTION SPECTRUM OF 3C 9. Sciama, D. W.; Rees, M. J. (Cambridge Univ., Eng.). Nature, 212: 1001-2 (Dec. 3, 1966).

It has been recently suggested that the spectra of quasars of large red shift would probably show absorption lines as a result of the gas contained in clusters of galaxies lying along the line of sight. It is pointed out that the recently published photoelectric spectrum of 3C 9 may show absorption by HI, CIV, and NV in a hot cloud with red shift z = 1.62. The spectrum is shown and the two apparent absorption features have wavelengths ~ 3180Å and 3240Å. (W.D.M.)

9284 INTERPLANETARY SCINTILLATION AND ITS RELATION TO THE ANGULAR STRUCTURE OF RADIO SOURCES. Little, L. T.; Hewish, A. (Cambridge Univ., Eng.). Mon. Notic. Roy. Astron. Soc., 134: 221-37(1966).

The recent discovery of interplanetary scintillation has provided a new technique for deriving information about the angular structure of radio sources in the range $0''{\cdot}1-1''$. A full account is given of the theory of the method and its practical application. The possibilities of the technique are illustrated by some typical observations at a frequency of 178 Mc. (auth)

9285 A RADIO STUDY OF THE NORTH POLAR SPUR. III. A CATALOGUE OF DISCRETE SOURCES. Quigley, M. J. S.; Large, M. I. (Univ. of Manchester, Eng.). Mon. Notic. Roy. Astron. Soc., 134: 239-43(1966).

The preparation of a list of 94 radio sources which have been observed with a total power system at a frequency of 240 Mc, in the region $8^h < \alpha < 16^h, -34° < \delta < +18°$, is described. A number of sources were detected, which are extended compared with the 1° beam. A brief discussion is given of the supernova theory of the origin of the Spur. For the most part, the radio observations seem to be consistent with the Spur's being an old supernova remnant. (auth)

9286 HARD X RADIATION FROM SOLAR FLARES. Gurzadyan, G. A. (Byurakanskii Astrophysical Observatory, Academy of Sciences, Armenian SSR). Dokl. Akad. Nauk Arm. SSR, 43: 28-31(1966). (In Russian).

An x-ray flare of $\sim 5 \times 10^7$ and $\sim 10^{10}$ photon/cm^2 sec for 0 to 8 Å and 8 to 60 Å regions, respectively, was recorded by a rocket on Oct. 1, 1965. A normal flux from the unperturbed sun is, ordinarily, ~0.0004 erg/cm^2 sec or $\sim 10^5$ photon/cm^2 sec for 0 to 8 Å and ~0.5 erg/cm^2 sec or $\sim 10^9$ photon/cm^2 sec for the 8 to 60 Å regions. Hence, the absolute increase of the x radiation was about an order of one for the 8 to 60 Å region and an order of three to four for the 0 to 8 Å region. The x-ray burst was neither of thermal or bremsstrahlung nature. However, it is postulated that it was induced in the sun's atmosphere and chromosphere layers by fast 10^6- to 10^7-eV electrons scattered on the ordinary light quanta. The appearance of the electrons is thought to have resulted from nuclear decay in the sun's depths, predominantly from sunspots. (R.V.J.)

9287 MAGNETIC FIELDS IN STELLAR BODIES. III. DISTORTION OF POLYTROPES. Monaghan, J. J. (Commonwealth Scientific and Industrial Research Organization, Sydney). Mon. Notic. Roy. Astron. Soc., 134: 275-85(1966).

The calculations described previously are completed by calculating the distortion of polytropes arising from a weak ($\leq 10^6$ gauss) dipole-like magnetic field. Detailed results are presented for polytropes of indices 1.0 and 3.0. These show that the dipole field effects a contraction of the polytrope of index 3 and an expansion of the polytrope of index 1. This result is explained simply in terms of the Lorentz force. (auth)

9288 POSSIBILITY OF DETERMINING THE DISTANCES AND MASSES OF STARS FROM THE GRAVITATIONAL LENS EFFECT. Refsdal, S. (Univ. of Oslo). Mon. Notic. Roy. Astron. Soc., 134: 315-19(1966).

It is shown that the distance and the mass of a star which acts as a gravitational lens can be determined if the lens effect can be observed from the Earth and from at least one distant space observatory. The distance from the Earth to the space observatory will usually have to be of the order of 5% of one astronomical unit or more. (auth)

9289 STIMULATED RADIO EMISSION OF THE INTERSTELLAR MEDIUM. Letokhov, V. S. (Lebedev Inst. of Physics, Moscow). JETP Lett. (USSR) (Engl. Transl.), 4: 321-3(Dec. 1, 1966).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Redaktsiyu, 4: 477-81(Dec. 1, 1966).

A number of anomalies were recently observed in the radio emission of the OH molecule in the interstellar medium (anomalous line-intensity ratio, strong circular polarization of the radiation in the absence of absorption polarization, very small width of the spectrum). It is shown that radio emission can be generated in an amplifying interstellar medium as a result of the feedback produced in scattering by free electrons or cosmic-dust particles. The properties of the "cosmic maser" differ appreciably from the properties of the "cosmic maser amplifier" and this explains the observed anomalies. (W.D.M.)

9290 SOLAR SPECTRUM IN THE NEIGHBORHOOD OF THE LITHIUM RESONANCE LINES. Daehler, Mark. Madison, Wis., Univ. of Wisconsin, 1966. 179p.

Thesis.

The astronomical interest concerning lithium in stellar atmospheres made it desirable to remeasure the solar spectrum near 6708 Å, the wavelength of the lithium resonance transitions $1s^2\,2s\,{}^2S_{\frac{1}{2}} - 1S^2\,2p\,{}^2P_{\frac{3}{2},\frac{1}{2}}$). Although the original intention was to obtain improved values for the $^6Li/^7Li$ isotopic abundance ratio and for the total lithium abundance, these questions were overshadowed by the evidence that the observed spectrum is not easily interpreted as lithium absorption. The experiment was performed at Kitt Peak National Observatory, using the McMath solar telescope and the PEPSIOS spectrometer, a photoelectric, pressure-scanned instrument whose dispersing elements consist of an interference filter and three Fabry-Perot interferometers. The spectrum was obtained over a range of 1½ Å, with a resolution of 300,000 and an rms smoothness of 0.014%. Fluctuations in source intensity were eliminated by electronically dividing the spectrometer signal by the signal from a reference detector. Relative wavelength calibration was provided by an auxiliary Fabry-Perot interferometer scanned at the same rate as the spectrometer, with the absolute wavelength calibration determined from the lithium resonance line produced in a laboratory hollow cathode discharge. Observations were made at seven center-limb positions along the solar equator. The resulting spectrum does not have the appearance of the lithium $^2S-{}^2P$ structure, which consists, for each isotope, of two components having a spacing of 151 mÅ and a 2 : 1 intensity ratio, with an isotope shift of 160 mÅ. At least part of the absorption feature must be due to some other atom or molecule. To help the interpretation, various assumed profiles, composed of sums of Gaussian-shaped components, were fitted to the data. The positions, half-maximum widths, and intensities of the components were computer-calculated to make a least squares fit. Excellent agreement with the data is obtained when the assumed profile in the immediate lithium region contains two lines which cannot be lithium components because of their wavelength spacing and their relative intensities. The agreement is not quite so good if the assumed profile contains the lithium lines plus one other component, even if a wavelength shift is permitted for the lithium structure. When the assumed profile includes the lithium lines, good agreement is obtained only when two additional, non-lithium lines are included. Favoring the simplest assumption, the conclusion is that the spectral region in question is composed of two absorption lines which are not those of lithium. (Dissertation Abstr.)

9291 STUDY OF VELOCITY FIELDS IN THE Hα CHROMOSPHERE BY MEANS OF TIME-LAPSE DOPPLER MOVIES. Title, Alan Morton. Pasadena, Calif., California Inst. of Tech., 1966. 142p.

Thesis.

The technique of Leighton for making Doppler spectroheliograms was extended to movies. Doppler movies made in Hα.7 Å from the core show a class of upgoing features with a 113 ± 3.4 second mean

lifetime and a definite velocity history. The velocity reaches its maximum in less than 30 seconds, then declines for the next 90 seconds. In the case of 27 percent of these features a similar upflow event occurred soon after the first had died away. The average lifetime of these "double" events is 236 ± 8 seconds, approximately twice the lifetime of a single event. No region has been observed to repeat more than twice in the time a region could be followed (about 15 m), nor has any showed a tendency to repeat after a lapse of more than 60 seconds. Moreover, the region on the sun where an upflow event has occurred tends to show no downflow for at least fifteen minutes afterward. (TTS)

Atomic and Molecular Physics

Refer also to abstracts 8506, 9668, and 9930.

9292 (IS-T-134) ELIMINATION OF THE SECOND COMPONENT OF THE LIFETIME IN POSITRON ANNIHILATION. Souder, Wallace William (Ames Lab., Iowa). Nov. 1966. Contract W-7405-eng-82. 69p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Thesis.

The lifetime of positrons in metals was investigated with the objective of establishing the existence, or nonexistence of a second, or "long" component. In order to minimize surface effects, the positron emitter ^{57}Ni was created throughout the volume of a nickel single crystal by the photonuclear reaction ^{58}Ni(γ,n)^{57}Ni. The reaction was induced by irradiation of the crystal with γ rays from the Iowa State University electron synchrotron. A time coincidence measurement system is described which employs a step-recovery diode for pulse-height compensation, and light emitting p–n junctions mounted on the phototubes to create reference pulses for gain shift stabilization. The time resolution for the experiment was 305 picoseconds FWHM. The intensity of the long component was reduced to less than 0.1% of that of the short component in nickel. A conventional (sandwich style with a ^{22}Na positron emitter) nickel sample was measured, and the intensity of the long component was 6 to 8% of the intensity of the short component. The mean lifetime, measured by the log-slope method, was 127.1 picoseconds (using the data obtained with the ^{57}Ni emitter). (auth)

9293 (MIT–952-3, pp 334-48) NUCLEAR PHYSICS. (Massachusetts Inst. of Tech., Cambridge. Dept. of Physics).

The following studies in nuclear physics are reported: actinium-227 decay series studies; internal conversion coefficient measurements; lithium drifted germanium detectors. (H.L.W.)

9294 (NASA-TN-D-3648) ABSOLUTE PHOTON YIELDS OF LIGHT ELEMENTS BY DEUTERON BOMBARDMENT. Caruso, Anthony J.; Walter, Robert A. (National Aeronautics and Space Administration, Cambridge, Mass. Electronics Research Center). Oct. 1966. 13p. CFSTI $3.00 cy, $0.65 mn.

Absolute measurements of K x-ray quantum yields resulting from deuteron bombardment of thick targets containing the elements carbon and boron were made. Characteristic x rays for deuteron energies ranging from 0.75 to 1.3 MeV were analyzed by pulse-height distributions obtained with a proportional counter. The proportional counter contained a Mylar-aluminum window for carbon radiation and a polypropylene window for boron radiation and was operated with P-10 gas (90% argon + 10% methane) flowing at atmospheric pressure. Deuterons were incident normal to the target surface and the photons were detected at 45° to the target. Carbon K pulse-height distributions produced by electron and deuteron bombardment of thick targets are presented to illustrate the absence of bremsstrahlung when deuteron bombardment is used. The results of the photon yields for carbon K ranged from 0.567×10^{-4} at 0.75 MeV to 3.17×10^{-4} photons per deuteron per steradian at 1.3 MeV; and for boron K, from 0.394×10^{-4} at 0.75 MeV to 1.15×10^{-4} photons per deuteron per steradian at 1.3 MeV. In all measurements, the uncertainty was less than 10 percent. (auth)

9295 (ORNL–4007, pp 121-69) RADIATION PHYSICS. Hurst, G. S. (Oak Ridge National Lab., Tenn.).

Various brief summaries of research are presented on the following areas: theoretical radiation physics, atomic and molecular radiation physics, interaction of radiation with solids and liquids, and physics of tissue damage. (M.O.W.)

9296 THEORETICAL AND EXPERIMENTAL ANALYSIS OF THE SPREAD OF AN IMMERSED FLOW BEAM. Nio, Koichi. NHK (Nippon Hoso Kyokai) Gijutsu Kenkyu, 17: 416-23; 436 (1965). (In Japanese).

The results are presented of theoretical and experimental analysis of the spread of an electron beam injected from a magnetic field to a magnetically shielded region. A theoretical analysis was made by the numerical solution of the paraxial ray equation. Results were obtained for ideal focusing conditions and for perturbed conditions that appear in ordinary focusing systems. It was found that the deviation of focusing conditions from the ideal has little effect on beam spread. (Int. Aero. Abstr.)

9297 EXTREMA-EFFECT IN TOTAL ELASTIC MOLECULAR BEAM SCATTERING CROSS SECTIONS FOR CHARACTERIZATION OF THE POTENTIAL WELL. Bernstein, R. B.; O'Brien, T. J. P. (Univ. of Wisconsin, Madison). Discuss. Faraday Soc., No. 40, 35-44(1965).

A review and an extension of the theory of the extrema effect in elastic impact spectra are given. The limiting high-velocity spacing of successive extrema on a plot is found to be inversely proportional to the product of the well depth times the interparticle separation at the potential minimum. Methods are discussed for the extraction of the maximum amount of information on the shape of the potential well from measurements of the extrema effect. (Int. Aero. Abstr.)

9298 LASER-INDUCED EMISSION OF ELECTRONS, IONS, AND X RAYS FROM SOLID TARGETS. Langer, P.; Tonon, G.; Floux, F.; Ducauze, A. (Commissariat a l'Energie Atomique, Paris). IEEE (Inst. Elec. Electron. Eng.) J. Quantum Electron., QE-2: 499-506(Sept. 1966).

The spatial distribution of electrons and ions emitted from a solid target when hit by a focused, Q-switched laser beam was studied. The particle emission is highly anisotropic. In a second experiment the ion energy for various targets was analyzed. Experiments were carried out with thick targets (thickness: 5×10^{-1} mm) and with 3 elements (Be, C, W). The ion energy spectra (laser flux was 6×10^{10} W/cm^2) are shown. There was a light intensity threshold for the appearance of multicharged ions. Threshold values for 4 carbon ions are given. The maximum ion energy was the same for the 4 ionization degrees. With a peak flux of 10^{11} W/cm^2 the maximum kinetic energy for carbon ions was about 2 keV. For a given laser intensity, the range of kinetic energy for each ionic species is shown. For instance, with a laser flux of 10^{10} W/cm^2, C^{2+} ions had energies between 100 and 1000 eV. It is concluded that ions having the highest ionization degree have the greatest mean energy. The high values of the ion kinetic energy suggested the existence of an accelerating electric field due to space charge separation, a thermal model not being sufficient to explain such high kinetic energy values. Evidence for x-ray emission during the interaction of the focused laser beam (λ = 10,600 Å at 3×10^7 W) with a metallic target was obtained. The laser beam was focused with a 4-cm lens on an iron target inside a vessel containing air at a residual pressure of 2×10^{-1} torr. (BBB)

9299 TENSOR PROPERTIES OF MOLECULES IN INTENSE STATIC ELECTROMAGNETIC FIELDS. Kielich, Par S. (Univ., Poznan, Poland). Acta Phys. Pol., 30: 851-76(Nov. 1966). (In French).

By using a general and compact tensor formalism, the diagonal matrix element of the second polar magnetic or electric moment of a molecule exposed to the effect of intense static electromagnetic fields was calculated. The calculations were made in approximations of the first, second, and third order of the perturbation calculation of quantum mechanics. Similar calculations of the energy of the perturbed molecule were made in the approximation up to the fourth order and a general relation was found between the order energy ($\underline{p}$ + 1) and the order moment $\underline{p}$ of the approximation. Moreover, quantum mechanical expressions were obtained for the diagonal matrix elements of the first-, second-, and third-order multipolar polarizabilities of the multipolar molecule. The formalism proposed was used for the calculation of different nonlinear effects whose study permits the direct obtaining of information on the permanent and induced molecular multipoles which determine the tensor properties of molecules in intense electromagnetic fields. A discussion based on the case of variations of the tensor of the electric permeability of a gas due to a homogeneous intense electric field with electric field gradients is given. The nonlinear variations of the tensor of the electric permeability produced by intense magnetic fields were considered. These effects, although low, can be measured partially under appropriate experimental conditions, which makes directly accessible, data on variation of the electric or the magnetic properties of the molecules due to an electric or magnetic field of the respective degree. (tr-auth)

9300 STUDY OF THE LUMINESCENCE OF CARBON MONOXIDE AND CARBON DIOXIDE EXCITED BY COLLISIONS WITH ACCELERATED IONS. Dufay, Maurice; Poulizac, Marie-Claude (Univ., Lyon). Mem. Soc. Roy. Sci. Liege, 12: 427-32(1966). (In French).

Spectrographic investigations were made of the luminescence of

CO and CO_2 gas bombarded by H^+ ions under reduced pressures ranging from 10^{-5} to 10^{-1} mm Hg at energy levels varying from 30 to 600 keV. An Arnulf–Lyot diffraction spectrograph was used to identify the radiation observed. Its intensity was then measured with a spectrometer connected to a photomultiplier. The various spectral bands in CO and CO_2 luminescence are described. The vibration structure of the CO^+ bands is discussed and the conditions required for establishing the intensity of radiation in terms of emitted photons and proton flux are derived. (Int. Aero. Abstr.)

9301 ELECTRICAL DISCHARGES IN BEAMS OF CONDENSED MATTER IN HIGH VACUUM. Klingelhoefer, R. (Kernforschungszentrum, Karlsruhe, Ger.). Beitr. Plasmaphys., 6: 253-73(1966). (In German).

Investigations are described which lead to an increase of the molecular density of condensed H_2 beams in high vacuum by approximately two orders of magnitude. Although for nuclear fusion experiments only beams of H_2 isotopes are of interest, a part of the development work was carried out with N_2 beams since the liquid to be used as nozzle coolant in this case is much easier to handle than liquid H_2. The results obtained with N_2 were tested on H_2 beams. It was shown that for condensed N_2 and condensed H_2 beams in high vacuum spatially sharply limited electric discharges of high current density can be ignited. In order to study the time behavior of the discharges, the discharge current was investigated with magnetic field poles and the light phenomena in the discharge with an image tube. The possibility of the production of spatially sharply limited electric discharges in condensed H_2 beams is of principal importance for fast tubular pinch devices. (tr-auth)

9302 PRESSURE WAVE GENERATION IN A FISSIONING GAS. IV. ANALYSIS BY THE METHOD OF CHARACTERISTICS. Podney, Walter N.; Smith, Harold P. Jr.; Oppenheim, A. K. (Univ. of California, Berkeley). Phys. Fluids, 9: 2357-64 (Dec. 1966).

Nonsteady, one-dimensional, fissionable gas motion induced in a semi-infinite, cylindrical tube of constant cross section by a spatially uniform neutron pulse, irradiating an initial segment of the tube, is formulated in terms of the method of characteristics, and a numerical solution describing the motion, prior to development of strong shock discontinuities, is obtained by finite differences with the use of an IBM 7094 computer. Resulting pressure pulses are compared with those obtained from a "bulk expansion" model, which assumes spatial uniformity within the irradiated gas. Although physical validity of this model has been ascertained by a satisfactory agreement between the two, an improved version, in the form of a "constant pressure gradient," model is proposed. Pressure pulses predicted by these models, which neglect wave interactions, are accurate for neutron pulse widths of the order of twice the irradiation length divided by the initial sound speed in the undisturbed gas. (auth)

9303 ORBITAL RADIATION OF ELECTRON SYNCHROTRON AND ITS USES. Oshio, Takanori (Osaka City Univ.); Sagawa, Takashi. Rigaku-Denki Janaru, 7: No. 5, 12-20(Dec. 1965). (In Japanese).

An electron which is moving with a circular orbit in an electron synchrotron is constantly emitting radiations of a continuous spectrum (Synchrotron Orbital Radiations). The SOR spectrum in the case of INS (Institute for Nuclear Study) Synchrotron (E_{max} = 750 MeV) starts at several Å in the short wave-length side and its smooth tail in the long wave-length side extends to infrared region, the peak value lying at 23 Å. Accordingly, the SOR beams form for themselves the best (highly polarized) light sources in the xuv region. A research group utilizing the "INS-SOR" made a start to carry out various works in this region. The electron beam monitoring through the image-forming of SOR (visible light), some preliminary measurements of INS-SOR spectra with an uv spectrograph or a grazing incidence spectrometer, measurements of characters of xuv electronic detectors and various absorption experiments with a grazing incidence spectrograph were carried out. K absorption fine structure of metallic Be, $L_{II,III}$, absorption fine structure of Al, $L_{II,III}$-absorption spectra of ionic crystals, and absorption spectra of He, Ne and Ar were clearly obtained. (NSA of Japan)

9304 FOCUSING OF AN ELECTRON BEAM FROM A LOW-NOISE GUN WITH DIFFERENT MAGNET SYSTEMS. PART V. TRAJECTORIES OF THE EDGE-ELECTRON IN THE MULTI-ANODE GUN REGION OF A LOW-NOISE TUBE. Chen, Tsung-shan (Radio Corp. of America, Harrison, N. J.). Int. J. Electron., 21: 305-28(Oct. 1966).

The trajectories traced by the outermost electron in a beam flowing in the gun region are investigated under the combined action of the accelerating electric field and focusing magnetic field. The beam profiles for four different low-noise guns have been calculated with the aid of a computer; their beam radii and boundary slopes occurring at the end of each gun have been determined when the magnetic flux density used in the gun region is varied. In properly compensated low-noise guns, the beam profiles in the accelerating region change less drastically than those found for guns having closely spaced anodes when the collimating magnetic field varies. Also, in the compensated case, the variations in radius and slope at different points along the beam boundary are comparatively moderate in contrast with such variations obtained in the latter case. A change in the magnetic field over the gun region, while it modifies the noise performance, affects significantly the initial boundary conditions with which the electron beam is launched into the interaction space of the tube. This phenomenon exercises some degree of control on the focusing of the electron beam in the helix region. (auth)

9305 CHARACTERISTICS OF A DUOPLASMATRON LOW ENERGY SPUTTERING SOURCE. Sreenivasan, T.; Farrell, G.; Carter, G. (Univ. of Liverpool). Int. J. Electron., 21: 367-80 (Oct. 1966).

An improved design of a duoplasmatron low-energy sputtering source, with its characteristics are presented. Operation of the present model shows that low arc and magnet currents (<0.5 A) are adequate. Very low-energy (100 eV) characteristics of the machine are described. An efficient extraction and focusing system employing a four-cylinder lens assembly is shown to be capable of producing a target current of the order of 1 mA (positive ions) at a target voltage of 60 V, the target being situated 4 in. away from the anode hole. A target current of 30 μA at 100 V—equivalent to a current density of 1 mA/cm²—using argon, can be obtained in the model described. (auth)

9306 CONCEPTION AND REALIZATION OF A VERY INTENSE SOURCE OF NEGATIVE HYDROGEN IONS H^-. Sautter, Jean-Michel; Baribaud, Michel; Dolique, Jean-Michel (Univ., Grenoble, France. ENESG, Grenoble, France). Compt. Rend., Ser. B, 263: 1211-14(Nov. 28, 1966). (In French).

On the basis of the results of a theoretical study on the formation and destruction of negative hydrogen ions in a reflex discharge, a very intense H^- ion source was conceived and developed: an initial version makes it possible to attain a continuous current of more than 5 mamp, the highest value obtained up to the present. (tr-auth)

9307 COLLECTIVE ATOMIC MOTIONS IN LIQUID ALUMINUM STUDIED BY COLD NEUTRON SCATTERING. Dahlborg, U.; Larsson, K. E. (Royal Inst. of Tech., Stockholm. Aktiebolaget Atomenergi, Stockholm). Ark. Fys., 33: 271-89(1966).

The neutron spectra scattered inelasticly from polycrystalline and liquid aluminium have been studied by means of the cold neutron technique. The polycrystal was kept at 630°C and the liquid at 677°C. It is found that approximate formulas based on the harmonic approximation relatively well describe the main features of the high temperature results of the solid phase. The liquid scattering picture shows very strikingly the same characteristics as the polycrystalline one. The experimental results are compared to different models such as the incoherent approximation, the extreme polycrystalline model of Egelstaff, and the extended convolution approximation derived by Singwi. The calculations show that a relatively good fit to the experimental results on liquid aluminium may be obtained either by a suitable choice of the frequency distribution assumed to exist in the liquid or by including the effect of polarization of the quasi-phonons in the cross section. The conclusion therefore is that with the present status of the theoretical development the available models contain too many arbitrary functions and constants such that a meaningful comparison to data is impossible. There remains, however, the experimental fact that the scattering pictures obtained from the high temperature polycrystal and the low-temperature liquid are strikingly similar in the range of momentum transfers investigated. (auth)

9308 MOMENTUM SPECTRUM RADIATED BY POINT CHARGES. Buzano, Carla. Atti Accad. Sci. Torino: I. Cl. Sci. Fis., Mat. Natur., 100: 837-50(1966). (In Italian).

The momentum spectrum radiated by a point charge moving in a homogeneous and isotropic medium was determined. The volume integral that appears in the expression of the momentum was transformed into a surface integral. The surface integral equaling a suitable spherical surface was calculated. The residual integrals are subjected to different transformations (integrations by parts). (J.S.R.)

9309 ELECTRON CORRELATIONS IN NARROW ENERGY BANDS. VI. THE CONNECTION WITH MANY-BODY PERTURBATION THEORY. Hubbard, J. (Atomic Energy Research Establishment, Harwell, Eng.). Proc. Roy. Soc. (London), Ser. A, 296: 100-12(Jan. 10, 1967).

The perturbation expansion about the atomic limit of paper V is derived from conventional many-body perturbation theory, thus exhibiting explicitly the relation of the two approaches. The derivation may be of practical use for the generation of related approximations in the two theories. (auth)

9310 ELECTRON CORRELATIONS IN NARROW ENERGY BANDS. V. A PERTURBATION EXPANSION ABOUT THE ATOMIC LIMIT. Hubbard, J. (Atomic Energy Research Establishment, Harwell, Eng.). Proc. Roy. Soc. (London), Ser. A, 296: 82-99(Jan. 10, 1967).

A perturbation expansion about the atomic limit in powers of the interaction between atoms is developed and a graphical analysis of the terms of the series is described. The manner in which the series degenerates in the band theory limit is discussed and a rule for generating approximations valid in both the atomic and band theory limits is given and applied to discuss the electron propagator. (auth)

9311 SPIN HAMILTONIAN FOR EXCHANGE INTERACTION IN THE RARE EARTH METALS. Druzhinin, V. V.; Irkhin, Yu. P. (Ural State Univ., USSR. Inst. of Physics of Metals, Academy of Sciences, USSR). Zh. Eksp. Teor. Fiz., 51: 1856-62(Dec. 1966). (In Russian).

The spin hamiltonian for exchange interaction between f-electrons and conductivity electrons is considered. Application of the irreducible tensor operator method and the Yusis–Levinson graphical methods yields simple analytical formulas for calculation of tensors involving various interactions of the nonheisenberg type. The sums involving products of the genealogical coefficients are expressed in terms of the standard reduced matrix elements of the type $\langle \gamma SL \,||\, V^{(kq)} \,||\, \gamma' S'L' \rangle$ most of which were tabulated. Some of the features of the properties of a number of rare earth metals due to the dependence of the hamiltonian coefficients on atomic number are discussed qualitatively, and it is mentioned in particular that the change in the direction of easy magnetization on transition from Ho to Er may be explained on basis of the change in sign of some anisotropic exchange coefficients. (auth)

9312 TRANSITIONS BETWEEN ATOMIC AND MOLECULAR IONS. Smirnov, B. M. Zh. Eksp. Teor. Fiz., 51: 1747-50 (Dec. 1966). (In Russian).

The coefficient for transformation of an atomic ion into a molecular ion as a result of triple collisions between the atomic ion and gas atoms is calculated. A case encountered in a gas discharge when the gas temperature is considerably lower than the molecular ion dissociation energy is considered. Transitions between the atomic and molecular ions in this case are determined by the polarization interaction between ions and atoms in triple collisions. An expression is derived for the ion transformation coefficient for the case when the atom, corresponding to the atomic ion, and the gas atoms are of the same or different type. (auth)

9313 ORTHOGONALITY ASSUMPTION IN THE HARTREE–FOCK APPROXIMATION. Froese, Charlotte (Univ. of British Columbia, Vancouver). Can. J. Phys., 45: 7-19(Jan. 1967).

Several procedures are considered for maintaining orthogonality between one-electron functions of the nsn's ^1S excited states as well as orthogonality to a lower state. The results are compared with those obtained without any orthogonality constraints. (auth)

9314 EFFECTIVE ELECTRON IMPACT EXCITATION AND IONIZATION CROSS SECTIONS FOR CESIUM, RUBIDIUM, AND POTASSIUM ATOMS IN THE SUB-THRESHOLD REGION. Korchevoi, Yu. P.; Przhonskii, A. M. (Kiev State Univ.). Zh. Eksp. Teor. Fiz., 51: 1617-21(Dec. 1966). (In Russian).

The effective cross sections for resonance excitation of Rb atoms (to the 5p level) and K atoms (to the 4p level) are measured in the subthreshold electron energy region by the "electron trap" method. The slopes of the initial linear sections of the excitation curves are 2×10^{-14} cm^2/eV for Rb and 7.5×10^{-15} cm^2/eV for K. The effective ionization cross sections for Cs, Rb and K atoms are measured in the subthreshold electron energy region by the "ion trap" method. For these elements the slopes of the initial linear segments are, respectively, 1.7×10^{-16}, 2.7×10^{-16}, and 2.2×10^{-16} cm^2/eV. (auth)

9315 POLARIZATION OF ATOMIC LINE RADIATION. II. OPTICAL EXCITATION AND ITS RELATIONSHIP TO ELECTRON IMPACT EXCITATION. Kleinpoppen H.; Neugart, R. (Univ., Tuebingen, Ger.). Z. Phys., 198: 321-8(1967).

The polarization of the first resonance lines of ^{6}Li, ^{7}Li, and ^{23}Na excited by linearly polarized light in a modulated crossed-beam experiment was measured. The results are as follows: ^{6}Li, degree of polarization P = (37.5 ± 1.7)%; ^{7}Li, P = (23.1 ± 1.3)%; ^{23}Na, P = (14.0 ± 0.8)%. These values agree with those calculated by means of Breit's theory for the polarization of resonance radiation and with the values of Hafner et al. for electron impact excitation at threshold. In accordance with the agreement the following relation has been established: the mechanism for electron impact excitation of alkali resonance lines at threshold is determined by the same selection rule ($\Delta m_l = 0$) as in the case of linearly polarized optical excitation. (auth)

9316 CLASSICAL SMALL-ANGLE SCATTERING FROM ANISOTROPIC POTENTIALS. Cross, R. J. Jr. (Univ. of Florida, Gainesville). J. Chem. Phys., 46: 609-18(Jan. 15, 1967).

A simple, direct method of calculating the small-angle scattering from an arbitrary anisotropic potential is derived. The approximations are valid for large energies or large impact parameters. Two methods are used, both yielding identical results. The first, an impulse approximation, involves integrating the force over the trajectory that would be followed if there were no interaction. The second method involves a perturbation solution of Hamilton's equations of motion. The first method is conceptually simpler, but the second yields a solution of the trajectory and is more easily generalized to include second-order effects. For scattering of ions and fast neutrals, molecular rotation can be neglected, and a simple expression is obtained for the differential cross section at small angles. This is applied to ion–dipole scattering where the potential is completely anisotropic, being repulsive for half the orientations and attractive for the other half. It is found that the differential cross section behaves exactly like that for a spherically symmetric potential given by $\mu e/2r^2$. However, when the ion–dipole potential is combined with a repulsive term in the potential, deviations from the behavior of spherically symmetric potentials are found. For scattering at thermal energies, the molecular rotation averages out the anisotropic terms in the potential, introducing further deviations from the behavior of spherically symmetric potentials. (auth)

9317 EVIDENCE OF SHELL EFFECTS AND THE APPROACH TO EQUILIBRIUM IN THE CHARGE-STATE DISTRIBUTIONS FOR 15 to 160 MeV ^{79}Br AND ^{127}I IONS IN CARBON. Moak, C. D.; Lutz, H. O.; Bridwell, L. B.; Northcliffe, L. C.; Datz, S. (Oak Ridge National Lab., Tenn.). Phys. Rev. Lett., 18: 41-3 (Jan. 9, 1967).

Equilibrium charge distributions of ^{79}Br and ^{127}I ions were obtained with an electrostatic analyzer. Influences of ionic shell structure upon the charge distributions were found. Thin carbon foils (8–78 μg/cm^2) were used to observe the approach to charge-state equilibrium. (auth)

9318 INVESTIGATION ON THE THERMIONIC DETECTION OF PHOTOIONIZATION SPECTRA OF CESIUM VAPORS. Popescu, I.; Ghita, C.; Popescu, A.; Musa, G. (Inst. of Physics, Bucharest). Ann. Phys. (7), 18: 103-11(1966).

A cesium-filled thermionic diode, working in the space-charge-limited mode, was used for obtaining further data on the mechanism of photoionization in cesium vapors. Particular emphasis was given to molecule photoionization, in the wavelength range of higher members of the principal series, corresponding cross section being estimated at 7×10^{-18} cm^2 for 3257 Å. The ions formed at a relative large distance (a few cm) from the thermionic detector were found to contribute substantially in the space charge neutralization. Data on the optimization of the cadmium absorption resonance line 3261 Å are also given. (auth)

9319 LITHIUM ION SOURCE FOR ELECTROSTATIC GENERATOR. Korol, V. M.; Siksin, V. S. At. Energ. (USSR), 21: 208-9(Sept. 1966). (In Russian).

A lithium ion source was developed using prepared lithium alumino silicate $Li_2O \cdot Al_2O_3 \cdot 2SiO_2$ coated on an electrically conducting tungsten spiral. A simple control using limit switches permitted installation of any filament over the retarding electrode. Tests were made for retarding potentials up to 10 kV. Tests were also made of cylindrical and conical spirals. The current in the filaments was 5.5 to 10 A. The maximum energy emitted from the filament did not exceed 20 V. (R.V.J.)

9320 CESIUM ION SPUTTERING OF ALUMINUM, COPPER, AND TITANIUM. Daley, Howard L.; Perel, Julius (Electro-Optical Systems, Inc., Pasadena, Calif.). AIAA (Amer. Inst. Aeronaut. Astronaut.) J., 5: 113-16(Jan. 1967).

Sputtering measurements have been made as part of a program to investigate the properties of selected materials for use as electrodes on cesium ion engines. The sputtering yields of polycrystalline aluminum, copper, and titanium were measured as a function of cesium ion energies ranging from 0.5 to 15 keV. The yield of powder metallurgy copper was also measured at cesium ion energies of 2, 5, and 7 keV. The polycrystalline and powder metallurgy copper results are compared with the single-crystal copper results are compared with the single-crystal copper data of Olson and Smith. The momentum transfer sputtering model of Rol, Fluit,

and Kistemaker was examined and compared with the experimental results. The comparison suggests a relationship between the functional dependence of the ion mean free path in the target lattice and a factor related to the target atom density per unit area. Comparisons with experiment show that for a given lattice structure material, the factor $(\rho/M)^{\frac{1}{3}}$ effectively averages the lattice orientations and can be used to predict yield ratios. (auth)

9321 CALCULATION OF IONIZATION POTENTIAL OF VARIOUS ATOMS. Iafrate, Gerald J. (Army Electronics Command, Fort Monmouth, N. J.). J. Chem. Phys., 46: 728-31 (Jan. 15, 1967).

A calculation of the ionization potential of various atoms has been done by assuming a pseudocore potential in the form of a simple analytical expression. The results calculated by using the variational method on hydrogenlike orbitals are in reasonable agreement with the experimental values. (auth)

9322 INVERSION OF VELOCITY-AVERAGED DIFFERENTIAL-CROSS-SECTION DATA TO AN INTERMOLECULAR POTENTIAL. Luoma, J. R.; Mueller, C. R. (Purdue Univ., Lafayette, Ind.). J. Chem. Phys., 46: 680-5(Jan. 15, 1967).

Utilizing generating functions, a method was constructed that retrieved the intermolecular potential from non-velocity-selected elastic-scattering data. These generating functions were tested and found to be a slowly varying function of the potential, thereby making them available for use in a linearized Taylor series expansion technique, coupled with a least-squares procedure, that inverted elastic-scattering data. The sensitivity of the averaged differential cross section to the form of the potential was noted. (auth)

9323 GAMMA-RAY ABSORPTION FROM POINT MONODIRECTIONAL GAMMA SOURCE IN PLANE GEOMETRY. Makhlis, F. A.; Sugak, L. A.; Plandin, E. A.; Shmyrev, I. K. At. Energ. (USSR), 21: 205-7(Sept. 1966). (In Russian).

The Monte Carlo method was used for determining absorption of γ radiation from a point monodirected ^{60}Co source distributed on a plane-parallel water-equivalent infinite surface of finite thickness. The energies of 5000 γ-quanta events were measured for absorption in annular coaxial layers at 3 to 5 cm spacing along the ΔR radius. Histograms for the energy absorption measured at γ-quantum angles of incidence of 0, 45, 60, and 75° are given. (R.V.J.)

9324 COMPTON EFFECT AND ELECTRON BINDING. Veigele, William J. (Kaman Nuclear, Colorado Springs, Colo.); Tracy, Philip T.; Henry, E. Michael. Amer. J. Phys., 34: 1116-21(Dec. 1966).

The usual expressions for the Compton effect are based on the assumptions that the scattering electron is free and stationary. These assumptions are reasonable when the photon energy is large compared to the electron binding energy; however, in many situations this is not the case, and the binding energy and momentum of the electron after Compton scattering by causing (1) line broadening, (2) a discrete spectrum, (3) a line-shift defect, (4) a decrease in incoherent scattering at low angles, (5) an increase in coherent scattering a low angles, and (6) a change in recoil electron distribution. These effects are described, and differential and average cross sections for carbon are calculated on the Thomas-Fermi model to illustrate them quantitatively. (auth)

9325 POLARIZATION OF ATOMIC LINE RADIATION. I. EXCITATION BY ELECTRON IMPACT. Hafner, H.; Kleinpoppen, H. (Univ., Tuebingen, Ger.). Z. Phys., 198: 315-20 (1967).

In order to test the predictions of the general theory for the polarization of atomic radiation excited by electron impact, the polarization of atomic lines in electron–alkali atom crossed-beam experiments was measured. The results show a typical behavior for the polarization of lithium and sodium resonance lines, which is contrary to earlier measurements such as those of Skinner and Appleyard: the polarization of the resonance lines increases monotonically from higher energies to the excitation threshold. The threshold polarization of the first resonance lines of ^6Li, ^7Li, and ^{23}Na is in good agreement with the calculations by Flower and Seaton. These results demonstrate that polarization is very sensitive to the natural level width, and to the fine and hyperfine structure separations of the excited states. Polarization of further lines has been investigated: an alkali line from an S to a P state is unpolarized as expected, but the polarization of a line from a D to a P state decreased in an unexpected manner near the threshold energy. (auth)

9326 ANGULAR DISTRIBUTION OF ELECTRONS SCATTERED ELASTICALLY BY RARE GAS ATOMIC BEAMS; POLARIZATION OF 40-eV ELECTRONS SCATTERED BY ARGON. Mehr, Josef (Johannes Gutenberg-Univ., Mainz). Z. Phys., 198: 345-50(1967). (In German).

The angular distribution of electrons scattered elastically by rare gas atomic beams (He, Ne, Ar, Kr, Xe) has been investigated over the angular range from 20 to 155° and with electron energies between 5 eV and 1000 eV. The results are compared with theory. Only for energies above 300 eV the agreement is good. The angular dependence of polarization $P(\Theta)$ of electrons elastically scattered by a beam of argon atoms is measured in a double scattering experiment for an electron energy of 40 eV. Maximum degree of polarization measured is $P = 12.5 \pm 2.5\%$. (auth)

9327 TEMPERATURE DEPENDENCE OF THE ABSORPTION COEFFICIENT OF MEDIUM FAST ELECTRONS IN POLYCRYSTALLINE ALUMINUM, SILVER, AND GOLD FOILS. Hansen-Schmidt, J. (Univ., Hamburg). Z. Phys., 198: 433-44(1967). (In German).

The absorption coefficients μ_{el} and μ_{unel} for fast electrons (30 to 50 keV) elastically and inelastically scattered in polycrystalline foils of Al, Ag, and Au have been measured at various temperatures between 160 and 600°K. It is shown that μ_{unel} decreases only slightly with temperature. The absorption coefficient μ_{el}, which is composed of μ_R for Laue Bragg scattering and μ_{TDS} for thermal diffuse scattering, increases with temperature. As μ_R and μ_{TDS} depend on temperature in opposite sense, the resulting increase of $\mu_{el} = \mu_R + \mu_{TDS}$ with temperature depends on the extent to which the temperature dependence of μ_R is reduced by dynamical extinction effects. For Al the measured temperature dependence of μ_{el} is in good agreement with the theoretical calculation of μ_{TDS} on the basis of the Einstein model and of μ_R according to the two-beam approximation of the dynamical theory. For Ag and Au the temperature dependence of μ_{el} is much more pronounced than for Al. This is due to the facts that for heavy elements the elastic scattering is stronger and dynamical extinction effects are generally more pronounced. In order to study the influence of dynamical extinction, the crystal size of the foils was varied. (auth)

9328 STUDIES OF ION–NEUTRAL REACTIONS BY A PHOTOIONIZATION MASS-SPECTROMETER TECHNIQUE. I. Warneck, Peter (GCA Corp., Bedford, Mass.). J. Chem. Phys., 46: 502-12(Jan. 15, 1967).

The use of a photoionization mass spectrometer for ion–molecule reaction studies is described. Ion-source pressures up to 200 μ are employed, measured directly with a McLeod gage. A method is described for determining ion residence times in the ion source at constant repeller field, using a pulsed-light source. Drift velocities, diffusion coefficients, and ion temperatures are given for N_2^+ ions in air as derived from an analysis of ion pulse shapes. Reaction studies are reported for nitrogen ions in air and nitrogen, and for hydrogen ions in hydrogen. The associated rate constants are derived. (auth)

9329 ORIENTATION-AVERAGED AMPLITUDE OF THE ONE-QUANTUM TERM IN THE NEUTRON SCATTERING LAW FOR MOLECULAR GASES. Carpenter, John M. (Univ. of Michigan, Ann Arbor). J. Chem. Phys., 46: 465-8(Jan. 15, 1967).

The amplitude of the one-quantum term in the scattering law for coherent scattering of neutrons by molecular gases is calculated using a generating-function approach. The phase factor $\exp(i\kappa \cdot b)$ is averaged jointly with the amplitude factor $(\kappa \cdot \gamma_i)(\kappa \cdot \gamma_j)$, as opposed to the more common technique of approximating the joint average by the product of the average of each factor. Results of example calculations show that the correction is of the same magnitude as the result of the conventional calculation. (auth)

9330 STUDIES OF ION–NEUTRAL REACTIONS BY A PHOTOIONIZATION MASS-SPECTROMETER TECHNIQUE. II. CHARGE-TRANSFER REACTIONS OF ARGON IONS AT NEAR-THERMAL ENERGIES. Warneck, Peter (GCA Corp., Bedford, Mass.). J. Chem. Phys., 46: 513-19(Jan. 15, 1967).

A photoionization mass spectrometer has been employed to study charge transfer involving $^2P_{\frac{1}{2}}$ argon ions at ion-source pressures 15 to 60 μ and with a source acceleration potential of 0.5 eV. The average energy of the reacting ions is calculated and found to be less than 0.17 eV. The following rate constants were obtained: $A^+ + NO \rightarrow A + NO^+$, $k = 3.9 \times 10^{-10}$ cc/molecule sec; $A^+ + O_2 \rightarrow A + O_2^+$, $k = 1.1 \times 10^{-10}$ cc/molecule sec; $A^+ + CO_2 \rightarrow A + CO_2^+$, $k = 7.0 \times 10^{-10}$ cc/molecule sec; $A^+ + CO \rightarrow A + CO^+$, $k = 1.25 \times 10^{-10}$ cc/molecule sec; $A^+ + N_2 \rightarrow A + N_2^+$, $k = 0.66 \times 10^{-10}$ cc/molecule sec. The theoretical implications are discussed. (auth)

9331 ATOMIC AND MOLECULAR PROCESSES IN THE UPPER ATMOSPHERES OF PLANETS. Shimizu, Mikio (Ochanomizu Univ., Tokyo). Rep. Ionosphere Space Res. Jap., 20: 271-88(1966).

The atomic and molecular processes in the upper atmospheres of Venus, Mars and Jupiter were investigated theoretically, by

using the atmospheric models recently proposed by the Jet Propulsion Laboratory group. The amount of CO molecules in the Cytherean and Martian upper atmospheres may be about 2 cm and 0.2 cm STP respectively, being the photochemical equilibrium assumed. The recombination of CO and O may result the airglow of the intensity ICB II, at most, at the bright side of Venus. On both Venus and Mars, the effect of diffusion should be taken into account to determine the distribution of O_2 molecules and the effect of the solar corpuscular stream on the upper atmospheres may be appreciable due to the lack of magnetism. On Jupiter, the molecular hydrogen and the atomic helium are first ionized and then decomposed to produce the atomic hydrogen whose ionization may be responsible for the formation of a dense Jovian ionosphere. The maximum electron density there was calculated as 1.5×10^7/cm^3 and the total amount of H atoms in the Jovian upper atmosphere may be 0.01 cm STP. In conclusion, a qualitative feature of the solar planetary relationships is described, based on the results of the above calculation. (auth)

9332 SOME CONSIDERATIONS ABOUT ION TRAPPING BY TUBULAR ELECTRON BEAMS FOR COLLISION EXPERIMENTS. Hartnagel, H. L. (Univ. of Sheffield, Eng.). Int. J. Electron., 21: 277-84(Sept. 1966).

For the study of electron–ion collision products, the space-charge density of a tubular electron beam can be employed in order to trap ions. This produces large ion densities on the axis of the electron beam, where a second thin beam is used for further collision processes. Design considerations for an optimal operation are developed. A few preliminary measurements are reported. (auth)

9333 ELECTROSTATIC FOCUSING OF AN ELECTRON-SHEET BEAM IN A SYMMETRIC PLANAR STRUCTURE. Udelson, B. J. (Harry Diamond Labs., Washington, D. C.). Int. J. Electron., 21: 241-76(Sept, 1966).

The relative merits of electrostatically focused electron-sheet beams are evaluated with respect to their use in both 0-type and transverse-field devices. Several practical structures for attaining this type of focusing are described. The parameters of interest in a symmetric planar electrostatic-focusing structure—beam perveance, transverse resonant frequency, beam stiffness, and the condition of beam instability—are evaluated analytically as a function of focusing-structure dimensions and applied focusing voltages. The analytic calculations are compared with digital-computer solutions of the paraxial-ray equation as well as with experiment. The beam motion in the unstable region and the electron motions within the beam are also investigated by analog-computer solutions of the paraxial-ray equation. Finally, methods for containing lateral beam spread are discussed. (auth)

9334 PARTICLE TRAJECTORIES IN HYPERBOLIC FIELDS: ABSOLUTE ELECTRODYNAMIC FIELDS. Boillat, Guy (Faculte des Sciences de Clermont, France). Compt. Rend., Ser. A, 263: 646-9(Nov. 2, 1966). (In French).

Two principles for the trajectories of particles in hyperbolic fields were proposed. It becomes the exceptional case of nonlinear electrodynamics; it is shown that there is then a nonperturbed orthonormal reference in the self-reference of the particle. Absolute fields of the given general exceptional Lagrangian are first considered and then photon trajectories. (tr-auth)

9335 HARTREE–FOCK THEORY OF ATOMIC PROPERTIES. Musher, Jeremy I. (Yeshiva Univ., New York). J. Chem. Phys., 46: 369-72(Jan. 1, 1967).

A procedure is presented for the calculation of atomic properties to any desired degree of accuracy using straightforward perturbation theory (PT). The uncoupled Hartree–Fock perturbation theory (UCPT) result is shown to agree with the first term of the PT expansion, while the coupled Hartree–Fock perturbation theory (CPT) result is shown to differ from the first two terms of the PT expansion only by higher-order terms. When the CPT result is improved upon using perturbation theory, all the coupling or self-consistency terms vanish identically and the result of the PT procedure is obtained. There is thus no advantage gained in performing the more difficult computations of CPT. The variants in UCPT discussed by Langhoff et al. are shown to be leading terms in the expansion of the UCPT result itself. (auth)

9336 THE INFLUENCE OF ADSORBED GAS ON PHOTON PRODUCTION BY LOW-ENERGY ELECTRON BOMBARDMENT. Baker, F. A. (Battelle Inst., Geneva). Brit. J. Appl. Phys., 17: 1559-67(Dec. 1966).

A study is made of the production of energetic photons when a gold target is bombarded by electrons of energy 200 eV or less. Photon detection is accomplished by means of electron ejection from a neighboring molybdenum surface. Better reproducibility of results than reported hitherto is attributed to the use of modern vacuum techniques and the minimization of charged particle flux from target to detector. Peak structure is observed in detector current as a function of bombarding electron energy. Significant and reproducible differences in such structure may be interpreted as characteristic of carbon monoxide and hydrogen adsorbed on the target surface. (auth)

9337 EXCITATION OF THE METASTABLE STATES OF HELIUM BY ELECTRON IMPACT. Dugan, J. L. G.; Richards, H. L.; Muschlitz, E. E. Jr. (Univ. of Florida, Gainesville). J. Chem. Phys., 46: 346-51(Jan. 1, 1967).

Measurements of relative electron-impact excitation functions for production of the metastable 2^1S and 2^3S states of helium in the range 25 to 135 eV have been made by observing the deflection of a beam of excited atoms in an inhomogeneous magnetic field. Effects of imprisonment and scattering of the beam have been eliminated by extrapolating the data to zero pressure, and the effect of photons in the beam separately determined. The ratio of the singlet to triplet functions obtained (including cascade contributions) varies from 0.26 to 2.37 in the energy range studied. (auth)

9338 SCATTERING OF HIGH-VELOCITY NEUTRAL PARTICLES. XIV. He–He INTERACTION BELOW 1.1 A. Jordan, J. E.; Amdur, I. (Massachusetts Inst. of Tech., Cambridge). J. Chem. Phys., 46: 165-83(Jan. 1, 1967).

Total elastic cross sections have been measured for helium atoms with energies between 300 and 2000 eV scattered by room-temperature helium through an effective laboratory angle greater than about 1×10^{-2} radian. Special features and procedures used in the experiments include the use of a magnetic field to increase the positive-ion current in the source, acceleration of the positive ions extracted from the source in a region of relatively low pressure with a consequent reduction in their energy spread, production of neutrals by charge transfer in a chamber separated from the scattering chamber, modulation of the neutral beam to produce an ac signal on a compensated thermal detector, and amplification of the detector signal with synchronous rectification, at the modulation frequency, of the amplifier output. A detailed analysis of the scattering results treats effect on the measured cross sections of the intensity distribution in the beam and of the beam-detector geometry, interpretation of the results in terms of different empirical monotonic potential functions (the exponential, the screened Coulomb, and the point repelling inverse power), and the effects of quantum scattering. Numerical values for the He–He potential between 0.61 and 1.12 Å for the three assumed potential functions show good internal consistency and agree with the best theoretical values within the combined estimates of the maximum uncertainties in the experimental and theoretical values. The mean potential obtained from the three empirical functions may be represented within about 1.8% by $V(r)_{mean} = 196 \exp(-4.21r)$ eV; $0.61 \text{ Å} < r < 1.12$ Å. (auth)

9339 ON THE INFLUENCE OF COULOMB EXCHANGE FORCES BETWEEN ELECTRONS ON THE RESIDUAL RESISTANCE IN MAGNETIC FIELDS. Keiter, Hellmut (Univ., Goettingen, Ger.). Z. Phys., 198: 215-35(1967). (In German).

Considering a gas of electrons, interacting via Coulomb's law, containing randomly distributed, fixed impurities, it is shown that the calculation of the diagonal components of the static electrical conductivity tensor in a uniform magnetic field may be based on a quasi-particle picture. The result holds at low temperatures in the first power of the density of impurities. (auth)

9340 ELECTRONS EJECTED FROM ALUMINUM BY 150-kVp TO 300-kVp X-RAYS. Matsuzawa, Hideo; Hoshino, Kazuo (National Inst. of Radiological Sciences, Chiba, Japan). Nippon Igaku Hoshasen Gakkai Zasshi, 26: 264-72(June 1966).

Experimental work was performed to study the equivalence of aluminum to bone in secondary electron emission produced by heterogeneous x rays. When an x-ray beam was incident normally on the surface of a plane aluminum slab, the energy spectra of electrons emerging from the rear surface of the slab were measured with a magnetic spectrometer at the different emerging angles. The results were compared with those obtained previously with bone. It was found that aluminum was fairly well equivalent to bone as far as the energy of emitted electrons was concerned, but not so exactly in the number of emerging electrons. The emerging electron flux was calculated by some approximation methods, and the results were compared with the experimental ones. It was found that the angular dependence of electron emission must be considered in calculating the electron flux for a high-Z material and for low-energy x rays. (NSA of Japan)

9341 PENETRATION OF MONOENERGETIC ELECTRONS THROUGH DIELECTRICS. Kuczera, Janina (Coll. of Agriculture, Wroclaw). Nukleonika, 11: 503-9(1966).

Penetration curves of monoenergetic electrons through dielectrics in the range of energy from 0.59 to 1.185 MeV were obtained. Investigations were performed for samples of seven different di-

electric materials. Experimental data led to a formula for calculating the relative intensity of the electron beam penetrating a substance. The formula involves the initial energy of electrons and the constants characteristic for a given substance, i.e., its density, effective atomic number and effective mass number. (auth)

9342 CALCULATION OF THE DIFFUSION COEFFICIENT TO MOBILITY RATIO OF ELECTRONS FOR NOBLE GASES. Orient, O. J. (Polytechnical Univ., Budapest). Acta Phys. Acad. Sci. Hung., 21: 293-302(1966).

Taking elastic scattering into consideration, but neglecting inelastic collision, with the application of the Boltzmann transport equation the equilibrium distribution function of electrons was calculated with a view to determine the energy dependence of the diffusion cross section. In the knowledge of the equilibrium distribution function the ratio D/μ of diffusion coefficient to mobility was determined. In the case of very low electric field strength the calculated equilibrium distribution function gives the Maxwell–Boltzmann distribution and $D/\mu = kT/e$. With increasing electric field strength the equilibrium distribution function passes through an intermediate distribution and finally gives the distribution calculated by Morse, Allis and Lamar. The ratio D/μ increases with the electric field strength. With the assumption of a diffusion cross section independent from energy in the case of higher electric field strengths the ratio increases linearly with the field strength. The results were applied to the calculation of the dependence of the ratio D/μ on electric field strength for helium and neon gases. The results were compared with measured data. (auth)

9343 THE LORENTZ PRINCIPLE AND THE GENERAL THEORY OF RELATIVITY. III. Janossy, L. (Central Research Inst. of Physics, Budapest). Acta Phys. Acad. Sci. Hung., 21: 329-44(1966).

The connection between the propagation tensor g and the sources of the gravitational field is investigated. It is shown that supposing light to be propagated isotropically with the velocity depending on gravitational potential, two of the three relativistic effects can be accounted for. The usual interpretation of the deflection of light is only obtained if one supposes that the propagation of light to be unisotropic in a gravitational field. Einstein's equations for the gravitational fields are derived from the point of view of the Lorentz principle. (auth)

9344 CALCULATION OF ATOMIC FORM FACTORS FROM STATISTICAL ELECTRON DENSITY DISTRIBUTIONS. Dobay-Szegleth, A. (Univ. for Technical Sciences, Budapest). Acta Phys. Acad. Sci. Hung., 21: 235-41(1966).

The atomic form factors and the cross sections for electron scattering are calculated for rare gases using a statistical atom model, which contains both the Dirac exchange energy and the improved kinetic energy correction of Gombás. Results are compared with the empirical data. (auth)

9345 DISTRIBUTION OF IONIZATION IN DISCHARGE GAPS IRRADIATED WITH RADIOACTIVE MATERIAL. Blair, D. T. A. (Univ. of Strathclyde, Glasgow). Proc. Inst. Elec. Eng. (London), 113: 2115-16(Dec. 1966).

Measurements have been made of the spatial growth of the gas-amplified current in a uniform-field discharge gap in nitrogen subject to the radiation from ^{60}Co source situated behind the surface of one of the electrodes. These measurements give information on the distribution of the initial ionization along the axis of such a gap. Results in methane were of the same form as in nitrogen. (auth)

9346 SPIN RELAXATION STUDIES IN ^3He GAS BY OPTICAL PUMPING. Schearer, Laird Delbert. Houston, Tex., Rice Univ., 1966. 150p.

Thesis.

A study is reported of the interaction of the ^3He (2^3S_1) metastable atom in a buffer of ground state ^3He (1^1S_0) atoms with the constituents of an electrical discharge and the interaction of the nuclear spins oriented by optical pumping with their surroundings. Various mechanisms for relaxation are explored to explain the observed dependence of nuclear polarization and relaxation times on light intensity and composition, discharge level, pressures, and magnetic field gradients. The spin relaxation time of the metastable atoms is determined primarily by collisions with hot electrons (several eV) involving excitation to a higher lying state. The ground state nuclear spin lifetime in the discharge is determined by atom-atom interchange collisions with the molecular ion or metastable molecule resulting in a loss of angular momentum from the system. It is shown that interactions between the ground state spin system and the discharge products dominate the optical process and limit the obtainable polarization. A new process for nuclear spin relaxation in low pressure gases exposed to magnetic field gradients was observed and investigated. The Brownian motion of the atom in a magnetic field gradient generates a time varying magnetic field which perturbs the spin system and influences significantly the spin-lattice relaxation time. A theory is developed to describe the effect which is supported in every respect by experimental observations in ^3He. The relaxation time is found to depend on the gas pressure, field gradient, and field intensity. In the absence of field gradients the 7 hr relaxation time provides a new upper limit on the size of the electric dipole moment of the ^3He nucleus, $\mu_e < 7 \times 10^{-15}$ e cm. (Dissertation Abstr.)

9347 PHYSICS AND TECHNOLOGY OF ION MOTORS. Proceedings of a Technical Meeting of the Combustion and Propulsion Panel at the 13th AGARD General Assembly, Athens, Greece, July 15–17, 1963. Marble, Frank E.; Surugue, Jean (eds.). AGARDograph 88. New York, Gordon and Breach Science Publishers, 1966. 435p. (CONF-630702–).

Separate abstracts were prepared for 10 of the 15 papers. The remaining papers were not in subject scope of NSA, and hence are omitted. (M.O.W.)

For abstracts of individual papers see: 9348–9352, 9364–9366, 9590, and 9591.

9348 SURFACE ION SOURCE PHENOMENA AND TECHNOLOGY. I. IONIZATION AND TRANSPORT PHENOMENA AND PERFORMANCE OF POROUS IONIZERS. Kuskevics, G.; Teem, J. M. (Electro-Optical Systems, Inc., Pasadena, Calif.). pp 3-78 of Physics and Technology of Ion Motors. Marble, Frank E.; Surugue, Jean (eds.). New York, Gordon and Breach Science Publishers, 1966.

Ion source requirements for electric propulsion applications make the use of surface or contact ionization, e.g., cesium ions evaporated from hot refractory metal surfaces, very attractive as an ionization method. The engineering development of such porous surface ion sources depends upon a thorough understanding of cesium ionization and transport phenomena both as related to the intrinsic material of which the porous diaphragms are made and on the dependence of these phenomena upon the structural form that is used to provide their porous characteristics. Such phenomena are reviewed and a summary is presented of the current status of experimental knowledge of both the fundamental phenomena and the consequent performance of practical, porous refractory metal cesium ion sources. Requirements for material properties, pore spacing, pore size and uniformity of permeability are discussed from an average or macroscopic viewpoint and also from a microscopic viewpoint of the ionizer material. (M.O.W.)

9349 SURFACE ION SOURCE PHENOMENA AND TECHNOLOGY. II. POROUS MATERIAL TECHNOLOGY. Teem, J. M.; Todd, H. H. (Electro-Optical Systems, Inc., Pasadena, Calif.). pp 79-101 of Physics and Technology of Ion Motors. Marble, Frank E.; Surugue, Jean (eds.). New York, Gordon and Breach Science Publishers, 1966.

The current status of porous refractory materials technology related to cesium contact ionizers is reviewed from a metallurgical viewpoint. Information is presented concerning ionizer materials requirements, the production of porous materials using wire, sheet, and sintered powder methods, a comparison of the metallurgical and ionizer properties of these various materials, methods of joining such porous materials to the nonporous refractory elements of vapor feed systems, and operating problem areas. The joining of porous ionizer materials to nonporous refractory materials, in order to effect permanent seals between the ionizer surface and the plenum chamber required to feed cesium vapor to its rear surface, has proven to be a difficult problem. The reasons for this and the solution of such problems, using both high-temperature brazing and electron beam welding techniques, are described in some detail. A final, most important requirement of porous ionizers—that they be capable of operating at high temperatures for thousands of hours without deleterious changes in their characteristics—is also discussed from the viewpoint of the metallurgical aspects of the problems connected with satisfying it. (M.O.W.)

9350 PHYSICS OF CHARGED COLLOIDAL PARTICLES AND THE TECHNOLOGY OF THEIR PRODUCTION. Hendricks, Charles D. (Univ. of Illinois, Urbana). pp 139-53 of Physics and Technology of Ion Motors. Marble, Frank E.; Surugue, Jean (eds.). New York, Gordon and Breach Science Publishers, 1966.

A brief history of the development of heavy particle propulsion is presented. The field is an outgrowth of electrical propulsion as suggested by Goddard, Oberth, Steinberg, and others. The heavy particle studies date from about 1952. Briefly, the methods of producing charged heavy particles, the scientists, their laboratories, and their techniques are surveyed. Advantages and disadvantages of the various methods of particle charging and production are discussed. Strong emphasis is placed on electrical spraying of liquids. A few of the most recent developments in this particular area are presented. (auth)

9351 PHYSICAL PHENOMENA IN BOMBARDMENT ION SOURCES. Kohlberg, I.; Nablo, S. (Ion Physics Corp., Burlington, Mass.). pp 155-206 of Physics and Technology of Ion Motors. Marble, Frank E.; Surugue, Jean (eds.). New York, Gordon and Breach Science Publishers, 1966.

A discussion of the important physical mechanisms and principles of operation of electron bombardment ion sources is presented with specific references to both the Lewis (NASA) geometry and the duoplasmatron configuration. The nature of the arc instabilities in the duoplasmatron and their ultimate interpretation as ion–acoustic wave phenomena are rendered together with a treatment of plasma characteristics measured in the baffled region of the arc. A brief review of the configuration and characteristics of sources of the Lewis (NASA) geometry is given. Data recorded during dc operation with mercury vapor and pulsed operation with the inert gases are used in a discussion of those parameters critical to the high performance of the source demanded in the engine application. Those phenomena of importance in the development of a working theory of ion source behavior are evaluated. Detailed treatments of the calculation of the electron distribution function in a weak magnetically confined plasma, resonance charge transfer and ion kinetics in the region of low electric field to pressure ratio, the process of anomalous diffusion, and the calculation of the radial potential and plasma distribution for the Lewis source are presented. The applicability of these considerations in interpreting the behavior of the Lewis-type source is then evaluated within the limits of the available experimental data. (auth)

9352 EXPERIMENTAL BOMBARDMENT ION SOURCE. McNeill, P. C. (Elliott Brothers (London) Ltd., Borehamwood, Eng.). pp 207-22 of Physics and Technology of Ion Motors. Marble, Frank E.; Surugue, Jean (eds.). New York, Gordon and Breach Science Publishers, 1966.

A 2.5-cm diameter bombardment ion source is described. Details of the performance are given and related to other published data. The maximum overall efficiency of the source was about 45% at a beam current density of about 3.0 mA/cm^2. The overall energy per ion was in the region of 10,000 eV. Although this value is large, it is generally consistent with the behavior of scaled sources as suggested by P. D. Reader. (auth)

9353 SPUTTERING IN A GLOW DISCHARGE. Coleman, Glenn Craddock. Norman, Okla., Univ. of Oklahoma, 1966. 134p.

Thesis.

The glow discharge is analyzed in great detail to determine the presence and energy of particles capable of producing erosion of the cathode. The quantity and energy of these particles are determined as a function of the parameters of the discharge. Known data are then applied to these particles to determine the amount of material removed. The material removed is of atomic size, hence it experiences collisions with the gas atoms which cause it to diffuse through the gas. The diffusion of this sputtered cloud is examined to determine what proportion will return to the cathode and what proportion will condense on the chamber walls. The difference between these two quantities determines the net amount of sputter to be expected. Laboratory studies of the amount of sputter produced in a glow discharge, with the parameters of the experiments varying over the greatest possible range, are then conducted. The laboratory data are compared with the predicted results, as determined from the theoretical analysis. The results achieved by the above attack justify the expectations for this method. The formula developed herein predicts observed results, in most cases, to within thirty percent and is applicable over a wide range of the parameters of the discharge. (TSS)

9354 PLASMA REACTIONS WITH POWDERED COAL. McDonald, Edward Harvey. Salt Lake City, Univ. of Utah, 1966. 104p.

Thesis.

A plasma jet was developed which would produce flame temperatures up to 8100°K. A method for determining plasma temperatures was developed, and temperatures were calculated for various mixtures and flow rates of argon, hydrogen, and nitrogen. High volatile and subbituminous Utah coals were reacted in plasmas containing only argon and plasmas containing mixtures of argon, hydrogen, and nitrogen. The results of the coal experiments were compared with experiments using methane, coke from the high volatile coal, and an activated charcoal. The major products produced were acetylene and hydrogen cyanide. The highest yields of these products were obtained from the high volatile coal. The coke and charcoal samples were relatively inert. It was concluded that the products were produced from the volatile matter in the coal. Quenching the reactions with a water spray did not change product yields on a distilled volatile matter basis. (Dissertation Abstr.)

Cosmic Radiation

Refer also to abstracts 8617, 9262, 9275, and 9734.

9355 HYSTERESIS OF COSMIC-RAY INTENSITY DURING THE RECENT SOLAR CYCLE. Kane, R. P. (Physical Research Lab., Ahmedabad, India). Nuovo Cimento (10), 46A: 690-7(Dec. 21, 1966).

Using the data for several pairs of neutron monitors, meson telescopes and ionization chambers, the hysteresis effect, i.e., the differential behavior in the rigidity dependence of long-term changes of cosmic-ray intensity during the rise, maximum and fall of the recent solar cycle was studied. In spite of indications of instrumental drifts, a significant hysteresis effect is observed. (auth)

9356 RADIO PULSES FROM EXTENSIVE AIR SHOWERS. Jelley, J. V. (Atomic Energy Research Establishment, Harwell, Eng.); Charman, W. N.; Fruin, J. H.; Smith, F. Graham; Porter, R. A.; Porter, N. A.; Weekes, T. C.; McBreen, B. Nuovo Cimento (10), 46A: 649-67(Dec. 21, 1966).

Radio pulses of short duration (<0.15 μs) have been observed at a frequency of 44 MHz (λ = 6.8 m), in coincidence with extensive cosmic air showers having ~$5 \cdot 10^6$ particles. The energies of these pulses ranged from ~10^{-12} erg (receiver noise level) to ~10^{-9} erg. The preliminary results reported briefly elsewhere were consistent with the hypothesis that the observed pulses arose as a result of enhanced Cherenkov radiation at low frequencies. However, following the treatment of Kahn and Lerche, it is evident that the observed energy of the radiation is also consistent with charge separation effects in the earth's magnetic field. Experiments at a higher frequency (150 MHz, λ = 2m), and a tentative analysis of the pulse-height spectrum, suggest that the radiation observed is enhanced by effects of mutual coherence among the particles in the shower. A discussion of other alternative radiation mechanisms is also included. (auth)

9357 PARTICLE-NUMBER DISTRIBUTION IN EXTENDED ATMOSPHERIC SHOWERS OF COSMIC RADIATION FOR HIGH PARTICLE NUMBERS. Somogyi, Antal (Central Inst. of Physical Research, Budapest). Magyar Fiz. Foly., 14: 377-439 (1966). (In Hungarian).

Recent measurements indicated that the number of nuclear active particles, N_M, in an extended shower, in which the total number of ionizing particles is N, may be expressed as: $N_M = c \cdot N^{0.6}$; this is in agreement with the energy independence of the properties of elementary interactions. However, the shape of the particle-number distribution curve continues to be controversial; therefore, new measurements were undertaken, subjecting the results to theoretical analysis, in order to establish whether the shape of the particle-number distribution spectrum may be reconciled with the observation that up to 10^{16} to 10^{17}-ev the properties of elementary interactions do not exhibit changes of a whole order of magnitude. The study presents also astrophysical interest. A cloud chamber controlled by G-M tubes was used for the density measurements; the exponent of the density spectrum, γ^*, in the $500 < \Delta < 4000$ particles/m^2 range was found to be $\gamma^* = 1.69 \pm 0.27$. No experimental facts were observed to indicate marked changes in elementary interactions in the 10^{14} to 10^{16} range. 105 references. (TTT)

9358 ABSORPTION PATH OF NUCLEAR-ACTIVE COSMIC RAY PARTICLES. Marikyan, G. A.; Matevosyan, K. A. (Erevan Inst. of Physics). Zh. Eksp. Teor. Fiz., 51: 1613-16(Dec. 1966). (In Russian).

The absorption path for the nuclear-active component of cosmic rays with energies up to 2×10^{12} eV is measured in aluminum and lead. The results of the measurements were used to determine the value of the exponent in the formula for the dependence of the nuclear interaction cross section on the atomic weight. The exponent is found to remain constant up to energies of 10^{12} eV and equals $^2/_3$. (auth)

9359 3 DEG K BLACKBODY RADIATION AND LEAKAGE LIFETIME OF COSMIC-RAY ELECTRONS. Cowsik, R.; Pal, Yash; Tandon, S. N.; Verma, R. P. (Tata Inst. of Fundamental Research, Bombay). Phys. Rev. Lett., 17: 1298-1300(Dec. 26, 1966).

It is suggested that the presence of a universal 3°K radiation provides a method of putting an upper limit on leakage life of cosmic-ray electrons and hence of primary cosmic rays. The equilibrium energy spectra of electrons are calculated for leakage lives of 2, 10, and 100 Myr and compared with experimental data. The calculated spectrum for a leakage lifetime of 10 Myr gives a good representation of the data. It is concluded that the leakage life of cosmic-ray electrons, and most probably of other particles,

cannot be much longer than 10 Myr, if the 3°K radiation does exist and if there is only one source of electrons up to a few hundred GeV energy. (A.G.W.)

9360 EVOLUTION OF RECURRENT VARIATIONS OF THE COSMIC RADIATION DURING THE SOLAR CYCLE. Freon, Andre; Macia, Gaspard (Laboratoire de Physique Cosmique, Essonne, France). Compt. Rend., Ser. B, 263: 1044-6(Nov. 2, 1966). (In French).

The observations by the conjugation of two effects whose relative importance varies during the cycle are interpreted: that of the recurrent active centers in which the rotation depends on the latitude at the solar surface and that of the deeper active regions in which the period is that determined by Carrington to define the solar rotations and by Bartels for the magnetic recurrences. (tr-auth)

9361 RADIO PULSES FROM COSMIC-RAY AIR SHOWERS. Barker, P. R.; Hazen, W. E.; Hendel, A. Z. (Univ. of Michigan, Ann Arbor). Phys. Rev. Lett., 18: 51-4(Jan. 9, 1967).

Radio pulses from air showers were detected in conjunction with the Bolivian Air-Shower Joint Experiment air-shower array, which permitted measurement of shower size, arrival direction, and core location. For the first time, good correlation was found between the shower arrival direction and the antenna pattern and between the shower size and the frequency of radio pulses; some correlation was found between the radio pulse height and the shower size and between the shower core location and the antenna position. (auth)

Direct Energy Conversion

Refer also to abstracts 9161, 9572, and 10219.

9362 CALCULATIONS OF MASS EXCHANGE IN LOW-TEMPERATURE HEAT EXCHANGER FOR MHD INSTALLATIONS. Styrikovich, M. A.; Godik, I. B. Izv. Akad. Nauk SSSR, Energ. Transp., No. 5, 105-12(Sept.-Oct. 1966). (In Russian).

Functional relations are developed for calculations on a stream of vapor–gas mixture with a low concentration of condensed vapor at the wall of a recuperative heat exchanger–condenser at given operational temperature. Mass exchange in superheated and saturated vapors is analyzed, specifically, using mercury–air vapor as the simulating system. (R.V.J.)

9363 THEORETICAL AND EXPERIMENTAL STUDY OF A LIQUID METAL MHD INDUCTION GENERATOR. Wang, T. C.; Dudzinsky, S. J. (Atomics International, Canoga Park, Calif.). AIAA (Amer. Inst. Aeronaut. Astronaut.) J., 5: 107-12(Jan. 1967).

A quasi-one-dimensional analysis is made of a linear-channel MHD induction generator without recourse to the usual idealization of the polyphase stator windings into current sheets. This analysis assumes that the stator windings and the induced current in the channel produce a resultant magnetic field at the stator surfaces of the form $B = B_m e^{j(\omega t - kx)}$, and, under the assumption of constant fluid velocity, the electromagnetic boundary conditions are applied to determine the magnetic field distribution throughout the generator. Taking into account real machine effects, expressions based on classical ac machine theory are given for the required exciting current, the generated voltage, the net power output, and the electrical efficiency. Specific criteria for neglecting skin effect are derived. An experimental generator, rated at 2 to 4 kW at 200 to 400 cps, 220 V, and 50 A, was designed and built on the basis of the analysis. Using NaK as the working fluid, the maximum power output to date has been 1.84 kW at 350 cps, 220 V, 43 A, with an average power factor of 0.11 lagging, and a net electrical efficiency of 36%. These results compare with the theoretically predicted power of 2.8 kW and efficiency of 42.8% for the test conditions. (auth)

9364 CAPILLARY EMITTER OF CESIUM IONS: APPLICATION TO THERMIONIC CONVERTERS. Huber, H.; Le Bihan, R. (Compagnie Generale de Telegraphie sans Fil, Orsay, France). pp 103-37 of Physics and Technology of Ion Motors. Marble, Frank E.; Surugue, Jean (eds.). New York, Gordon and Breach Science Publishers, 1966. (In French).

The operational principles of filament emitters as a source of cesium electrons and ions are developed. A theoretical model is discussed for the emitter. The application of this emitter to thermionic converters is discussed. (M.O.W.)

9365 THERMIONIC CONVERSION OF ENERGY. Picquendar, J. E. (Compagnie Francaise Thomson Houston, Bagneux, France). pp 359-74 of Physics and Technology of Ion Motors. Marble, Frank E.; Surugue, Jean (eds.). New York, Gordon and Breach Science Publishers, 1966. (In French).

Operational principles of thermionic converters are discussed. Other conversion devices are also briefly mentioned. (M.O.W.)

9366 DEVELOPMENT TRENDS IN THE FIELD OF THERMIONIC ENERGY CONVERTERS IN GERMANY. Knoernschild, Eugen M. (Deutsche Versuchsanstalt fuer Luft- und Raumfahrt e.V., Cologne). pp 375-89 of Physics and Technology of Ion Motors. Marble, Frank E.; Surugue, Jean (eds.). New York, Gordon and Breach Science Publishers, 1966.

German activity in the field of thermionic converters encompasses vacuum magnetic triodes, cesium diodes, and noble gas triodes. Theoretical investigations indicate that the important loss mechanism in vacuum triodes with superposed magnetic field is the scattering of electrons on their curved path from emitter to collector. Electron trajectories for two configurations of magnetic triodes are discussed. In the field of cesium diodes the main emphasis is on arc mode operated converters. Efforts are directed towards increasing the optimum spacing between emitter and collector by the use of cesium fluoride. A cesium coating on a substrate of fluorine on tungsten permits a considerably larger spacing of the electrodes. Further investigations are concerned with the plasma resistance for normal and arc mode operation. A strong influence of the spacing with arc mode operation on power output of the diode has been noted. In the field of noble gas triodes several configurations are being tested in Germany. Promising results have already been obtained. A few test data on the various configurations are presented. The possibility of intermittently generating ions followed up by emission of electrons is investigated. An optimum gas pressure can be established where the loss of ions, due to diffusion and recombination, is a minimum. (auth)

9367 POWER CONVERSION. Rosa, Richard J. (Avco-Everett Research Lab., Everett, Mass.). pp 347-88 of Plasma Physics in Theory and Application. Kunkel, Wulf B. (ed.). New York, McGraw-Hill Book Co., 1966.

The basics of operation of plasma diodes and MHD generators are discussed. Overall design considerations are described. (M.O.W.)

9368 EFFECT OF IMPURITY GAS ON THE OPERATION OF A THERMIONIC CESIUM DIODE. Backus, Charles Edward. Tucson, Ariz., Univ. of Arizona, 1966. 110p.

Thesis.

The effects of overpressures of argon, krypton, xenon and iodine on a cesium diode operating in the arc mode were determined. By assuming that the effect of the inert gases is only to increase the scattering collisions, their effect can be calculated from the transport equation. The good agreement of the calculated and experimental results supports the validity of the assumption that the inert gases act only as a diffusion barrier. The iodine changed the work function of the emitter and also changed the mode of operation from the arc mode to an ion rich mode. The diode power increased with iodine addition until a vapor pressure of about 40 torr. At this point the diode power was 2.1 times the initial power. The output power then decreased with additional iodine pressure until it reached its initial power level at about 120 torr of iodine pressure. (TSS)

9369 RADIATION TRANSPORT IN THE CESIUM THERMIONIC CONVERTER: A PLASMA MODEL AND AN EMITTER HEAT BALANCE. Gelhaus, Floyd Elmer. Ithaca, N. Y., Cornell Univ., 1966. 177p.

Thesis.

Under the formalism of a plasma model, the transport of radiation is shown to be important in determining the density and spatial distribution of electrons and ions in the cesium plasma of a thermionic converter in the arc mode. The steady state equations including radiation transport are solved numerically using known or physically plausible values for the rate constants. Electron and ion densities are given as a function of position, rate of excitation, and selected values of the rate constants. The solutions pertain to the case that the rates of production and recombination of electrons and ions outweigh the rates of diffusion. They show that concentrations and distributions resembling those observed, for example, by Bullis and Wiegand result from the above processes if the rate constants fall in what appear, in view of the lack of experimental data, to be reasonable ranges. Further, it is shown that radiation transport constitutes an important part of the heat flow at the emitter surface. Using a derived heat balance equation in conjunction with Wilson's and Lawrence's experimental emitter cooling measurements, it is shown that the molecular ion is the dominant plasma ionic specie during converter operation at low current densities and that the density of atomic ions increases with increasing current. This increase in the Cs^+ density is shown to result from an increase in the amount of collisional and radiative population of the upper levels of the atom, events which allow

approach to total local thermodynamic equilibrium and stepwise excitation to produce the atomic ion. (TSS)

Fluid Physics

9370 (ORNL-P-2740) MAGNETOHYDRODYNAMIC STABILITY ANALYSIS OF JET-INJECTION FLOW OVER A CONCAVE WALL. Chang, T. S.; Sartory, W. K. (Oak Ridge National Lab., Tenn.). [nd]. Contract W-7405-eng-26. 11p. (CONF-661111-2). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

From Annual Meeting, American Physical Society, Fluid Dynamics Division, Stanford, Calif.

The theoretical portion of this investigation consists of two parts: a calculation of the primary velocity profile in a jet-driven vortex tube, and an MHD stability analysis of the resulting flow. The primary flow is observed experimentally to consist of a thin boundary layer near the outer tube wall in which the influence of the driving jets and viscous wall drag are felt, and an interior region in which angular momentum is conserved. This investigation is concerned mainly with the outer boundary layer in which the flow is essentially two-dimensional and unaffected by the magnetic field. (auth)

9371 FOUR SIMPLE EXAMPLES OF RELATED HYDRODYNAMIC AND MAGNETOHYDRODYNAMIC FLOWS. Geffen, Nima (TECHNION, Haifa, Israel). Israel J. Tech., 4: 70-6 (Feb. 1966).

Four discontinuous one-dimensional nondissipative flows are described for (1) a free-surface perfect liquid conductor in a magnetic field aligned with the flow, where a magnetohydraulic jump may occur, (2) a perfect gaseous conductor in an aligned magnetic field with a normal magnetogasdynamic shock, (3) a free-surface ideal liquid with a hydraulic jump, and (4) an ideal gas with a normal shock. The last three cases are well known and will be summarized briefly; the case of a perfect liquid conductor is new, and will be treated in more detail. An analogy among four cases is shown, and one set of equations for all of them given. Possible extension of this work to two-dimensional problems and to the crossed-field case is pointed out. (auth)

9372 VISCOUS EFFECTS IN THE LIQUID CONDUCTOR MODEL OF HARD-CORE PINCH. Murty, G. S. (Tata Inst. of Fundamental Research, Bombay). Proc. Indian Acad. Sci., Sect. A, 63: 145-65(Mar. 1966).

The influence of viscous forces on the instability of liquid conductor model of hard-core pinch is investigated theoretically. It is shown that these forces decrease considerably the growth rate of instability in the experiments of Lehnert and Sjögren. An order of magnitude of the reduction is obtained for the experimental conditions. It is suggested that as a result of viscous forces, the time scale of instability, if any, is so large that instabilities cannot be observed in these experiments when the inner and outer currents are parallel. (auth)

9373 ON GENERALIZED MHD COUETTE FLOW WITH HEAT TRANSFER. Soundalgekar, V. M. (Milind Coll. of Science, Aurangabad, India). Proc. Indian Acad. Sci., Sect. A, 64: 304-14(Nov. 1966).

In the case of short-circuited generalized MHD Couette flow the rate of heat transfer, in general, increases with the increase in the value of both the Hartmann number and the pressure gradient. Especially, at the lower stationary plate it is affected by the magnetic field, which is not observed in the case of plane MHD Couette flow. (auth)

9374 ASYMPTOTIC LAW OF DECAY OF HOMOGENEOUS MAGNETOTURBULENCE. Nihoul, Jacques C. J. (Univ., Liege). Phys. Fluids, 9: 2370-6(Dec. 1966).

Solutions of the magnetohydrodynamic equations for the spectral energy tensors are obtained by assuming that the turbulent field is homogeneous and weak enough for triple correlations to be negligible. The total turbulent magnetic and kinetic energies are derived by integrating over all wave number space. The asymptotic law of decay (for times larger than the "inhibition time") is obtained in an analytical form by the method of steepest descent, and it is shown that there are two important contributions to the total energy, one which decays as $t^{-\frac{3}{2}}$, as in ordinary turbulence and corresponds to equipartition between magnetic and kinetic modes, and one which decays as t^{-3} and leads to the partition of energy between the two modes in the inverse ratio of their respective diffusivities. In the course of the decay, the latter becomes negligible, but the time at which the $t^{-\frac{3}{2}}$ component dominates depends upon the ratio $n = \nu/\lambda$ of the two diffusivities and is found to fall beyond any reasonable time of observation if n is much less or much larger than one; in which cases, equipartition is not approached before the turbulence is damped out or has attained such a large scale that, in experimental situations, the limit of validity of the homogeneity hypothesis is reached. (auth)

9375 PROPAGATION OF OBLIQUE SHOCK WAVES IN MAGNETOHYDRODYNAMICS. Cherkasova, K. P. Ukr. Fiz. Zh., 11: 1302-6(1966). (In Ukrainian).

The restrictions imposed by sweep conditions on oblique magnetohydrodynamic shock waves added to the vertex of the streamline angle are investigated. A case is considered in which the magnetic field is directed parallel to the flow velocity. It is shown that the sweep conditions in some cases permit rejecting superfluous solutions not prohibited by the general conditions of propagation. (auth)

9376 OSCILLATING RIGID BODY PROBLEM IN MAGNETOHYDRODYNAMICS. Arora, Kasturi L. (Univ. of Colorado, Boulder). Proc. Nat. Inst. Sci. India, Pt. A, 32: 14-22(Jan. 1966).

The flow field set up by the oscillatory motion of an arbitrary rigid body in a viscous, incompressible and electrically conducting fluid with a transverse magnetic field is studied. It is assumed that the kinematic viscosity and the electrical conductivity are constant throughout the flow field, and that the perturbation in the basic magnetic field is small. The excess charge density and the imposed electric field are assumed to be zero. The expressions for the velocity profile, the frictional force and the energy dissipation are derived. The motion of the fluid is shown to consist of a heavily damped plane sheer wave, the coupling between the different layers being due to viscous friction and magnetic field. The analysis is carried out in two stages: first for an infinite plane and second for a body of arbitrary shape. (auth)

9377 ON TURBULENT MHD FLOW IN PIPES OF RECTANGULAR AND ROUND CROSS SECTION. Branover, G. G.; Gelfgat, Yu. M.; Tsinober, A. B. Magnit. Gidrodin., No. 3, 3-21(1966). (In Russian).

A short survey of state-of-the-art in experimental and half empirical investigation of this problem is presented. Analysis of transition from laminar to turbulent flow is being carried out. For two-dimensional flow in the presence of transverse field several variants of half empirical theory are proposed. Simple interpolation relations for friction coefficient calculation and velocity distribution are proposed. New experimental data are presented. (auth)

9378 GAS FLOW WITH CONSTANT CROSS SECTION IN REGION M > 1. Druzhitskii, V. V.; Popov, G. A.; Tikhonov, V. B. Magnit. Gidrodin., No. 3, 22-8(1966). (In Russian).

The features of conducting gas supersonic flow in a coaxial duct are considered, the magnetic field produced by plasma current being taken into account. A one-dimensional analysis of a nonviscous nonheat-conducting plasma with isotropic conductivity is carried out assuming the flow velocity to be less than the drift velocity. It is shown that streamline flow can exist only if certain relations between the initial values of the Mach numbers, the flow velocity to the drift velocity ratio and the magnetic pressure to hydrodynamic pressure ratio are valid. Theoretical results for a variation of parameters along the duct for various initial conditions are presented. (auth)

9379 CONICAL MGD FLOW TAKING INTO ACCOUNT HALL EFFECT IN PRESENCE OF AXIAL MAGNETIC FIELD. Bertinov, A. I.; But, D. A.; Gorbatkov, S. A. Magnit. Gidrodin., No. 3, 29-38(1966). (In Russian).

A conical magnetogasdynamic flow of an ideal incompressible conducting gas in the presence of axial magnetic field is considered taking into account the Hall effect. Electric power taken from the electrodes is due to Faraday and Hall effects. Magnetic Reynolds number is assumed to be much less than one. Analytical relationships for electrodynamical and energetic flow characteristics estimation have been derived. Optimization of output power relating to various parameters is being carried out. It is shown that the power per unit volume due to the above mentioned flow is less than in the case of MGD flow in the presence of transverse magnetic field. Nevertheless there is no need of isolated duct walls when the above mentioned effect is applied. It leads to the increasing of the admissible body temperature, simplification of the duct construction and the increasing of reliability of the device. (auth)

9380 EDGE EFFECTS IN MHD CHANNEL WITH VARIABLE CROSS SECTION. Benenson, E. B.; Genkin, A. L. Magnit. Gidrodin., No. 3, 39-44(1966). (In Russian).

Linearly diverging magnetohydrodynamic channels are considered. Fringe effects due to finite electrode and isolator length as a function of the channel divergence angle was determined. The results show that the fringe effects in a diverging channel to be greater than in the case with a constant cross-section. (auth)

9381 INFLUENCE OF IONIZATION PROCESS ON STRUCTURE PAST THE SHOCK WAVE IN PRESENCE OF MAGNETIC FIELD. Gusika, P. L.; Sukhov, G. S. Magnit. Gidrodin., No. 3, 45-54(1966). (In Russian).

A qualitative analysis of the structure of flat magnetogasdynamic shock waves was carried out on the basis of one-dimensional equations in the single-liquid approach with consideration of the ionization process. The results of numerical calculations of flow parameters behind the shock wave are compared with the data obtained neglecting the ionization process. (auth)

9382 MAGNETOHYDRODYNAMIC JET FLOW IN LIMITED SPACE. Branover, G. G.; Shcherbinin, E. V. Magnit. Gidrodin., No. 3, 55-63(1966). (In Russian).

An experimental investigation of the velocity distribution of the immersed jet in the presence of a transverse magnetic field was carried out. Essential changes in flow structure under the influence of the magnetic field were established. (auth)

9383 NONSTATIONARY TWO-DIMENSIONAL MAGNETOHYDRODYNAMIC CHANNEL FLOW WITH PRESSURE GRADIENT ARBITRARY CHANGING IN TIME. Ryabinin, A. G. Magnit. Gidrodin., No. 3, 64-8(1966). (In Russian).

A theoretical investigation of nonstationary flow of viscous uncompressible conducting fluid in the presence of transverse magnetic field, the pressure gradient arbitrarily changing in time, is considered. Two particular cases of unsteady flow of fluid are considered—with sudden application of constant pressure gradient and with the pressure gradient changing in time according to the exponential law. (auth)

9384 HEAT TRANSFER IN PLANE LIQUID CONDUCTING JET. Sokovishin, Yu. A. Magnit. Gidrodin., No. 3, 76-82(1966). (In Russian).

Heat transfer in a plane conducting fluid jet spreading on the flat wall in the presence of transverse magnetic field is discussed. It is assumed that the magnetic field is applied to the fourth region where the value of the jet height coincides with the boundary layer thickness. At small magnetohydrodynamic interaction parameters the solution for the temperature distribution is obtained in the form of infinite series. It is shown that even small increase of the MHD-interaction parameter causes a reasonable intensification of the heat transfer. (auth)

9385 SOME APPROXIMATIONS IN ELECTRODYNAMICS OF MOVING MEDIA. Pavlovskii, R. A. Magnit. Gidrodin., No. 3, 146-8(1966). (In Russian).

Application of the classical electromagnetic field equations in certain cases of moving media in the presence of external magnetic or electric fields is considered. (auth)

9386 EFFECT OF MAGNETIC PLASTICITY IN NON-NEWTONIAN LIQUIDS. Martinson, L. K.; Pavlov, K. B. Magnit. Gidrodin., No. 3, 69-75(1966). (In Russian).

One-dimensional magnetohydrodynamic conducting flow under rheological power law is considered. The influence of non-Newtonian properties of the medium on the flow character was investigated. (auth)

9387 MAGNETODYNAMIC NON-STATIONARY SLOW MOTION OF AN ELECTRICALLY CONDUCTING VISCOUS LIQUID IN A SPHERICAL ENVELOPE. Ignat, Margareta. Atti Accad. Sci. Torino: I. Cl. Sci. Fis., Mat. Natur., 100: 851-68(1966). (In Italian).

The possibility of slow nonstationary motion of the liquid contained in a spherical envelope, and on which is applied a uniform magnetic field oriented toward the constant unit vector $\underline{a}$, was analyzed. The general equations to satisfy the magnetic field and the velocity and the equations for the vortex vector and the conduction current density vector were found. The formulas determining the vortex and density vectors at a point inside the envelope were deduced. The generalized Green formula for the velocity, pressure, and magnetic field was established for the conditions considered. (J.S.R.)

9388 HOMOGENEOUS TURBULENCE IN THE PRESENCE OF A UNIFORM MAGNETIC FIELD WHEN THE REYNOLDS MAGNETIC NUMBER IS SMALL. Moreau, Rene (Univ., Grenoble, France). Compt. Rend., Ser. A, 263: 585-8(Oct. 24, 1966). (In French).

The equation of spectral tensors of the second order was derived. These spectral tensors were reduced to an axisymmetric form. There is coherence of a simplified axisymmetric turbulence model in which the spectral tensors are reduced to their isotope tensor structure component in which the scalar varies with the directions. (tr-auth)

9389 FIRST APPROXIMATION FOR THE FLOWS IN MAGNETOHYDRODYNAMIC SHOCK TUBES WITH EFFECTS OF EXTREMITIES AND NON-UNIFORM ANISOTROPIC ELECTRIC CONDUCTIVITY. Nguyen-Ngoc-Tran (Centre de Calcul Analogique, Chatillon-sous-Bagneux, France). Compt. Rend., Ser. A, 263: 639-42(Nov. 2, 1966). (In French).

On the assumption that the magnetic interaction parameter N was small, the first approximation of the flows in magnetohydrodynamic shock tubes was studied under the effects of extremities and tensor nonuniform electric conductivity. By neglecting the perturbation of the magnetic field ($R_M \ll 1$), the problem becomes that of determining the current function ψ' and the electric potential φ' and the pressure p^1. (tr-auth)

9390 SOME FUNDAMENTAL MECHANISMS OF HOMOGENEOUS TURBULENCE IN THE PRESENCE OF A UNIFORM MAGNETIC FIELD WHEN THE REYNOLDS MAGNETIC NUMBER IS SMALL. Moreau, Rene (Univ., Grenoble, France). Compt. Rend., Ser. A, 263: 635-8(Nov. 2, 1966). (In French).

Equations are given for the magnetic and kinetic energy of the turbulence. The electric energy and the role of fluctuations of the electric field are expressed. The dissipation by Joule effect of space of the wave numbers is localized. There is local isotropy at the level of small vortices. (tr-auth)

9391 HYDROMAGNETIC FLOW. Cole, Julian D. (California Inst. of Tech., Pasadena). pp 207-32 of Plasma Physics in Theory and Application. Kunkel, Wulf B. (ed.). New York, McGraw-Hill Book Co., 1966.

The general equations for hydromagnetic flow are presented. Various dimensionless parameters are introduced and significant limiting cases discussed. The effects of finite electric conductivity on some basic flows, due to compression and due to shear, are briefly discussed. An example of magnetically driven shock waves is analyzed, and the basic ideas of channel flow are discussed. (M.O.W.)

9392 MHD CHARACTERISTICS AND SHOCK WAVES. Kantrowitz, Arthur; Petschek, Harry E. (Avco-Everett Research Lab., Everett, Mass.). pp 149-206 of Plasma Physics in Theory and Application. Kunkel, Wulf B. (ed.). New York, McGraw-Hill Book Co., 1966.

The MHD equations are described for linear waves. The extension from the linear waves. The extension from the linear to the nonlinear case is discussed. It is shown that two of the modes of linear propagation lead to the formation of shock waves. The resulting two types of shock waves are extensively described. (M.O.W.)

9393 ANALYTICAL STUDY OF THE EFFECT OF VISCOSITY ON THE STABILITY OF AN INFINITE FLUID SLAB CARRYING A UNIFORM EXTERNAL CURRENT. Gokhale, M. H. (Tata Inst. of Fundamental Research, Bombay). J. Math. Anal. Appl., 16: 486-509(Dec. 1966).

A plane infinite slab of weakly conducting, nonmagnetic, incompressible fluid has one of its surfaces free and the other in contact with a plane insulating rigid boundary. A uniform external gravitational force acts on the fluid in a direction perpendicular to the rigid boundary from the free surface. An external current of uniform volume density is passed parallel to its surfaces and is closed symmetrically at infinity. The total current passing through the system at any instant of time is maintained constant by means of the external source. The stability of the static equilibrium of the system is considered by normal mode analysis. (M.H.R.)

9394 CERTAIN REDUCIBLE HELICAL HYDROMAGNETIC FLOWS. Rogers, C. (Stafford Coll. of Technology, Eng.). Appl. Sci. Res., 16: 380-94(1966).

Intrinsic formulations are obtained of the equations governing three-dimensional steady flows of an inviscid magnetic fluid with infinite electrical conductivity both when the streamlines of the magnetic field H and the fluid velocity v everywhere have the same unit tangent, and when H lies in the normal plane to the fluid streamlines at every point, so that $v \times H = 0$ and $v \cdot H = 0$ respectively. Using these intrinsic equations certain results concerning hydromagnetic helical flows are derived, and particular classes of such flows are reduced to associated nonmagnetic two-dimensional flows. Finally, reciprocal relations are used to link classes of hydromagnetic helical flows to four-parameter classes of ordinary fluid flows. (auth)

9395 STEADY TWO-DIMENSIONAL MAGNETOHYDRODYNAMIC FLOW. Gundersen, Roy M. (Univ. of Wisconsin, Milwaukee). Z. Angew. Math. Phys., 17: 755-65(1966).

Several authors have considered two-dimensional, steady, flows of an ideal gas and have obtained solutions to various specialized problems, usually based on linearized forms of the basic equations. A detailed examination is made of the structure of the equations which govern the two-dimensional, steady flow of an ideal, inviscid, perfectly conducting compressible fluid in the special case where the applied magnetic field has but one nonzero component. (W.D.M.)

9396 MEASUREMENTS OF FLOW VELOCITIES IN AN MHD CHANNEL. Shirakata, Hirofumi; Matsunaga, Sakuro; Hiramoto, Tatsumi; Yano, Syukuro (Japan Atomic Energy Research Inst., Tokyo). Jap. J. Appl. Phys., 5: 1107-13(Nov. 1966).

A direct determination of the flow velocity was made by the flight time measurement of the luminous cloud in the plasma flow composed of K_2CO_3-seeded-argon gases. The experimental error in the measurement of velocity was 6.3% (standard deviation). The velocity values obtained in this way were compared with those obtained by two other indirect methods: one based on the mass conservation equation of plasma flow, and the other on the use of MHD electromotive force. By making some assumptions on the turbulent velocity distribution in a smooth pipe, the local velocity was evaluated by the first indirect method. The values obtained were in fairly good agreement with those determined by the direct method and by the second indirect method. A few corrections which should be made for obtaining reliable results by the two indirect methods are described. (auth)

9397 SPECTROSCOPIC INVESTIGATION OF A HYDROGEN ARCJET PLUME. Mastrup, F. N. (TRW Systems, Redondo Beach, Calif.). AIAA (Amer. Inst. Aeronaut. Astronaut.) J., 5: 159-61(Jan. 1967).

The exhaust at various H mass flow rates down to zero flow was studied to answer the following questions: (1) What causes the thrust in the H shutoff mode? (2) Does this thrust have an effect on the thrust during normal operation? The results of the spectral scans from different plume regions allow the following conclusions to be made: With no H feed into the arc, the innermost region is predominantly neutral tungsten gas. The surrounding region has a WII, but no WI, spectrum, and hence has considerable current flow. No emission from WI or WII is observed in the outer region, whose spectrum is dominated by the negative bands of N_2^+. Spectra from N^+, O^+, N, or O were entirely absent; hence, the thrust originated mostly from ablated electrode material. As the H mass flow is reduced, the arcjet system has a tendency to ablate tungsten from the electrodes. (D.L.C.)

9398 STEADY-STATE HARTMANN MHD COAXIAL FLOW BETWEEN CYLINDERS. Sugai, Iwao (System Sciences Corp., Falls Church, Va.). AIAA (Amer. Inst. Aeronaut. Astronaut.) J., 5: 157-9(Jan. 1967).

The solution for steady-state Hartmann flow between two parallel plates is extended to the coaxial flow between two concentric circular cylinders. The problem of finding the location of no induced magnetic field in order to solve the equations is considered. The hyperbolic sine and cosine integrals are more complicated than in the parallel-plate problem. (D.L.C.)

9399 CORRELATION OF NOZZLE SUBMERGENCE LOSSES IN SOLID ROCKET MOTORS. Kordig, James W.; Fuller, Gerald H. (Hercules Inc., Magna, Utah). AIAA (Amer. Inst. Aeronaut. Astronaut.) J., 5: 175-7(Jan. 1967).

The equations for an idealized, one-dimensional MHD accelerator are solved to yield an asymptotic solution valid for large times and a numerical solution for small times which can be scaled for any case where current and velocity are initially zero. In the asymptotic region, the displacement is shown to be proportional to $t^{\frac{1}{2}}$ in lowest order, with the next term varying as $t^{\frac{1}{3}}$. (D.L.C.)

Geophysics

Refer also to abstracts 8582, 8663, 8664, 9262, and 9331.

9400 (AD-643918) HIGH RESOLUTION ULTRAVIOLET SPECTRAL STUDY OF THE AURORA IN ASSOCIATION WITH SATELLITE EXPERIMENT. Final Report. Young, Robert A. (Stanford Research Inst., Menlo Park, Calif.). Oct. 24, 1966. Contract DA-49-146-XZ-356. 25p. (DASA-1874). CFSTI $3.00 cy, $0.65 mn.

Two spectrometers were adapted for use in aircraft-based observations of auroral events, airglow, or high-altitude nuclear tests. The instruments feature image tube detection and wide spectral coverage. The instrumentation and trials in aircraft and on the ground are described and illustrated. (auth)

9401 EXPERIMENTAL MEASUREMENT OF THE ENERGY DISTRIBUTION OF SECONDARY ELECTRONS IN AN AURORA. Doering, John P.; Fastie, William G. (Johns Hopkins Univ., Baltimore). Can. J. Phys., 44: 2948-51(Nov. 1966).

Preliminary results of a rocket-borne measurement of the energy distribution of secondary electrons from 40 to 900 eV in an active aurora are presented. Data were obtained with a 180° hemispherical electrostatic deflection analyzer which swept the differential electron spectrum continuously between 40 and 900 eV. An Aerobee 150 rocket was launched from Fort Churchill, Canada, into an active aurora of intensity greater than IBC II on Feb. 20, 1966, at 5:30 U.T. A maximum altitude of 170 km was reached. (W.D.M.)

9402 THE COMPUTATION OF THE MAGNETIC FIELD OF ANY AXISYMMETRIC CURRENT DISTRIBUTION: WITH MAGNETOSPHERIC APPLICATIONS. Kendall, P. C. (Geophysical Inst., College, Alaska); Chapman, S.; Akasofu, S.-I.; Swartztrauber, P. N. Geophys. J., 11: 349-64(Nov. 1966).

It is shown that the vector potential A of the magnetic field of any axisymmetric electric current distribution can be expressed in the form $\Sigma A_n(r)P_n^1(\cos\theta)$. This series is used to compute the field of two model magnetospheric ring currents; the field of one of these was previously determined by double integrations by Akasofu, Cain & Chapman. The calculation of the functions $A_n(r)$ does not require double integrations. The two sets of results are in good agreement. The first term in the series for A gives the external magnetic moment of the ring current. The magnetic field energy is calculated for the field as a whole and for each term in the series for A. The field isointensity lines are drawn, and also the field lines for the ring current and for its field combined with that of the geomagnetic dipole. They illustrate the considerable distortion of the field in the magnetosphere during magnetic storms. The series for A may also be helpful in calculating the paths of cosmic rays in the deformed magnetosphere. The numerical convergence of the results is improved by the use of Cesàro summation. (auth)

9403 FORM OF THE MAGNETOSPHERE OF A STRAIGHT CURRENT IN A DIVERGENT PLASMA FLOW. Morgenroth, H. Beitr. Plasmaphys., 6: 235-52(1966). (In German).

The shape of the interaction layer between a magnetic field and a plasma flowing against the field depends essentially on the plasma pressure at the layer. In the present work a pressure distribution was used which represents, for a divergent cold plasma flow in mirror symmetrical reflection, the heavy particles at the layer. The divergent flow shape corresponds when the particle is emitted radially from a source. It, however, also agrees when at first parallel emitted particles were so deflected that their backward altered flight path is cut approximately at one point. The divergent flow form represents a modification of the parallel model flow to the Newton $\cos^2\theta$ law. The pressure distribution was discussed in connection with the solar wind problem and connected with a two-dimensional problem in which the magnetic field was produced by a linear current. The results were compared with the analogous problem for parallel particle orbits. (tr-auth).

9404 IONOSPHERIC LAYERS IN THE INFRARED REGION OF THE SPECTRUM. Markov, M. N.; Merson, Ya. I.; Shamilev, M. R. Dokl. Akad. Nauk. SSSR, Earth Sci. Sect., 167: 1-4 (Sept. 1966).

Measurements of intensity of ir radiation made in the ionosphere were correlated with solar flare activity. Between 1958 and 1963 systematic measurements of terrestrial and atmospheric radiation were recorded in the spectrum range 0.8 to 40 μ at heights of 25 to 500 km. Observations were made at different times of the year (June, August, October) in areas several thousand kilometers apart. The research equipment was lifted into the ionosphere by balloons and rockets. These measurements showed that there is intense ir radiation at altitudes above 200 km. The radiation in the upper atmosphere is most intense at heights of 250 to 300, 420 to 450, and about 500 km. The radiation observed at these heights is concentrated chiefly in the 2.5 to 8 μ region of the spectrum in the sunlit part of the atmosphere. The radiation of the upper atmosphere has a max intensity of as much as 3 to 7×10^2 W/m^2, sighted in a tangential direction, when the radiation is integrated along a beam of ~1000 km in length, a fact consistent with isotropic radiation of 1 cm^3 equal to 10^{-3} erg/sec. The radiation intensity is a function of the action of solar radiation on the upper part of the atmosphere and increases in periods of peak solar activity. The ir radiation of the ionosphere was correlated with flares near the central meridian of the solar disc. (BBB)

9405 RESULTS ON IONOSPHERIC DRIFT MEASUREMENTS AT THE E-LAYER LEVEL IN THE WINTER OF 1962-3 IN COMPARISON WITH THE EARLIER YEARS 1959-61. Schminder, Rudolf (Geophysikalisches Observatorium, Collm ueber Oschatz, Ger.). Beitr. Geophys., 73: 21-30(1964). (In German).

Measurements have been made at the Geophysical Observatory at Collm (51°18,6'N; 13°00,2'E) since 1959 by the Krantkraemer method, employing radio transmissions at the long wavelength region (272 Kcps) from a station in Czechoslovakia at a distance of 400 km. During the winter of 1962-1963 (October 18, 1962 to February 23, 1963), east-northeast drifts were recorded. Before

and after this period, southwest drifts were observed. The average drift speed was of 47 m/sec. In winter the level of the reflections was slightly below a marginal region presumed to be at an altitude of 100 km above which SW drifts were measured. The vertical extension of the turbulence zone could be determined to be about 1.5 km. Comparisons were made with measurements for the years 1959 to 1961. Diurnal components were not observed. (BBB)

9406 FADING CHARACTERISTICS OF RADIO WAVES REFLECTED FROM THE E_S LAYER AT THUMBA. Rastogi, R. G.; Kaushika, N. D.; Deshpande, M. R. (Physical Research Lab., Ahmedabad, India). Ann. Geophys., 22: 380-4(July-Sept. 1966).

Measurements of the horizontal drift in the E region of the ionosphere over Thumba in Southern India (8°32′N, 76°52′E) have been made regularly since January 1964. The method consisted of recording the amplitude variation of radio waves singly reflected from the ionosphere at 3 points on a triangle separated by about 1 wavelength. A frequency of 2.2 Mcps was used for E region drifts. Results of an analysis of the fading characteristics of radio waves reflected from the sporadic E layer of the ionosphere over the magnetic equator showed that the fading has a strong diurnal variation, being very rapid during morning and evening hours and very slow during the midday hours. The fadings were of impulsive nature consisting of short bursts of signal strength over a relatively low average intensity. The probability distribution of the amplitude of signal strength did not fit the theoretical Rayleigh or Gaussian distribution. The angular spread of the reflected waves was calculated and found to be slightly larger than that for higher latitudes. (BBB)

9407 POLARIZATION OF HYDROMAGNETIC OSCILLATION OF THE Pc-1 TYPE OBSERVED AT 2 COORDINATED GEOMAGNETIC STATIONS. Gendrin, R. (Groupe de Recherches Ionospheriques, Paris); Lacourly, S.; Gokhberg, M.; Malevskaya, O.; Troitskaya, V. A. Ann. Geophys., 22: 329-37(July-Sept. 1966). (In French).

Polarization of Pc 1 hydromagnetic oscillations recorded at the 2 linked stations at Sogra (USSR) and Kerguelen (South Indian Ocean) was studied. The analysis was made both from a magnetic tape recorder and a paper one, the speed of which is 600 mm/min. It was shown that, generally, the oscillations propagate from one hemisphere to the other in a specific mode (left or right). Sometimes there is a mixing of 2 simultaneous emissions of slightly different frequencies and with opposite polarizations. At Sogra, the large axis of the polarization ellipse is directed along the North. The consequences of observations on some theoretical points are discussed. The observation of elliptical polarization with the absence of pure circular polarization is considered. This polarization cannot be attributed to a simple effect of the sun assuming that the direction of the long axis of the ellipse is the same at different stations. (BBB)

9408 IONOSPHERIC ABSORPTION MEASUREMENTS AT COLOMBO, CEYLON. Gnanalingam, S.; Ratnasiri, P. A. J. (Ceylon Inst. of Scientific and Industrial Research, Colombo). Ann. Geophys., 22: 361-7(July-Sept. 1966).

Systematic measurements of ionospheric absorption at vertical incidence were made by the pulse reflection method on frequencies in the range 2 to 3 Mc at Colombo (06°54′N, 70°52′E, magnetic dip 5°S) for the IGY, IGC, and IQSY. The data were used to investigate the variation of absorption with solar activity and sun's zenith distance χ. The noon absorption L on 2.6 Mc was found to increase with sunspot number R_z according to the law $L = L_0 (1 + bR_z)$ for values of R_z up to about 180. The mean value of the coefficient "b" is 5.1×10^{-3}, and $L_0 = 31.6$ db for $\chi = 0$. The seasonal variation of absorption obeyed a law of the form $L \propto \mathrm{Cos}^{1.7}\chi$, except for the period from May to September when the absorption was abnormally low. The diurnal variation was of the form $\mathrm{Cos}^n\chi$, where n has an average value of 0.9 for all the frequencies used. (BBB)

9409 IMPROVEMENT IN DEVICES TO MEASURE THE WINDS AND DIFFRACTION OF RADIOELECTRIC WAVES IN THE IONOSPHERE. Haubert, A.; Doyen, G. (Centre de Recherches Geophysiques, Garchy, France). Ann. Geophys., 22: 338-48(July-Sept. 1966). (In French).

After a discussion of results obtained during the Geophysical Year on ionospheric winds, by the use of the 3-receiver method, an improvement of this method by use of multiple receiving antennas is described. A description is given of the device in use at the Centre de Recherches Geophysiques de Garchy. An array of 36 receiving dipoles is distributed horizontally in a square area, 150 × 150 m, and, by scanning, a television picture appears on the screen of a cathode ray tube, in such a way that any radioelectric diffraction pattern produced by anomalies in the ionosphere can be seen on the screen as bright and shadowed figures. The main improvement brought by the device is avoidance of any correlation calculation, the coherence and continuity of the movements being evident through the multiplicity of antennas. This improvement in the analysis of diffraction patterns provides new elements to ionospheric plasma mechanisms studies. With regard to measurements of velocities and directions of winds, interesting comparisons are now possible, with a nearby station observing displacements of meteor trails by radar. (BBB)

9410 THE INFLUENCE OF CURVATURE OF THE EXTREME LINES ON THE RESULTS OF IONOSPHERIC DRIFT MEASUREMENTS IN THE LONG-WAVELENGTH RANGE. Schminder, Rudolf (Geophysikalisches Observatorium, Collm ueber Oschatz, Ger.). Z. Meteorol., 16: 315-17(1963). (In German).

Ionospheric drift measurements were made at the Geophysical Observatory at Collm (51°18.6′N; 13°00.2′E) by the Krautkraemer method in the long wavelength region (272 Kc). Such measurements have been recorded since 1959 using radio signals sent by a transmitter in Czechoslovakia, at a distance of 400 km from the receiver. Measurements obtained in the 6-month period from June to November, 1962, are described and discussed. These data indicated that the error originating from the extreme line curvature in the results of ionospheric drift measurements by the Krautkraemer method occurs with long wavelength measurements to the order of magnitude of the reading errors. The importance of 4 point measurements, which were used to recognize the extreme line curvature in the present study, is mainly in its applicability as a check of the evaluation data. (BBB)

9411 SOME PHYSICAL ASPECTS OF THE IONOSPHERE. Bell, D. A. (Univ. of Hull, Eng.). Radio Electron. Eng., 32: 217-26(Oct. 1966).

Present knowledge of the properties of the ionosphere is reviewed, in particular those which have become more important or more accurately known through the use of sounding rockets and artificial earth satellites. The following topics are discussed: the wave-electron interaction and incoherent scattering from electrons, properties of the D, E, and F regions, and scatter propagation. Some results have suggested that there is little ionization below 85 km but more detailed examination shows that during the day there are electron densities of the order of 200 to 1000/cm^3 in the range from 65 to 100 km. This density is not sufficient to reflect frequencies in the megahertz range, and since the collision frequency of the electrons is between 10^6 and 10^7/sec, the attenuation of such frequencies is high, accounting for the failure of medium-frequency waves to propagate via the ionosphere in daytime. Intense radiation from solar flares can cause the ionization to extend down below 50 km and lead to severe absorption of frequencies from 100 KHz up; but it has little effect on vlf transmissions at 15 to 30 KHz. Sporadic E reflection is apparently often caused by thin patches of relatively intense ionization which are sharply defined in height, and some of them are correlated with wind shear. There is at present no satisfactory explanation for the various forms of sporadic E which are found, but they occur sufficiently frequently to be a significant factor in radio communications. The F2 region shows greater variation with the sunspot cycle than other regions. (BBB)

9412 FARADAY ROTATION AND OTHER MEASUREMENTS ON THE IONOSPHERE AT NAIROBI. Hunter, A. N.; Webster, A. R. (Univ. Coll., Nairobi, Kenya). Ann. Geophys., 22: 385-92(July-Sept. 1966).

Ionospheric measurements by means of vertical incidence sounding were commenced at Nairobi in January, 1964, and observations on Faraday rotation of the 40, 41, and 20 Mc transmissions from the satellite B.E.B. (S. 66) were started on October 10, 1964. The ionosonde was coupled to the satellite receiving equipment so that an ionogram was automatically obtained immediately following each recorded satellite pass. The geographical coordinates of the station are 36.82°E, 1.32°S, with a dip of 26.9°. Results obtained for the variation of total electron content over the first year of observation of satellite B.E.B., together with associated ionospheric parameters from vertical sounding, are presented. Estimates of the peak electron content of the F2 layer and the height of this max in ionization density were obtained from vertical incidence sounding over a similar period. These parameters are also presented on a diurnal and seasonal basis. The relation between these quantities is discussed and some attempt at explaining particular features made. (BBB)

9413 LATITUDINAL EFFECTS ON SATELLITE SCINTILLATIONS. Aarons, J.; Silverman, H. M.; Ramsey, B. A. (Air Force Cambridge Research Labs., Bedford, Mass.). Ann. Geophys., 22: 349-55(July-Sept. 1966).

Three stations ranging in latitude from 18.5°N to 76°N were

used to study signals in the 20-40 Mc range from the S-66 (BE-B) satellite beacon during the April 17–30, 1965, period. Additional data taken both at earlier and later times were used to supplement the study. Two specific diurnal periods were investigated: 0200–0430 EST and 1400–1700 EST. The Thule (76°N) passes recorded scintillation indices of 70–100% a large portion of the time. A boundary curtain of irregularities seems to exist at all times, although both the index and rate of the scintillations seem slightly less over the geopole than over the auroral zone. Evidence pointed to the fact that the angle of elevation was of less importance than the subionospheric latitude of the ray path from satellite to ground. The presunset time period showed low indices at low latitudes gradually increasing with latitude until the boundary curtain was reached at 57°–60° geomagnetic latitude at the 350-km subionospheric point; the indices then move rapidly into the completely scintillating regime in the auroral zone. The postmidnight period results indicated that medium amplitude scintillations of 30–40% exist from low to subauroral latitudes. (BBB)

9414 SATELLITE SCINTILLATION OBSERVATION DURING LOCAL SUMMER AT LOW SOUTHERN GEOMAGNETIC LATITUDES. Radicella, S. M.; Cosio de Ragone, A. H. (Univ. Nacional, Tucuman, Argentina). Ann. Astrophys., 29: 356-60 (Sept.-Oct. 1966).

Records of the 40-Mc signal of the Explorer XXII (S-66 Satellite) taken at Tucuman (26.9°S, 65.4°W), during local summer, were analyzed to examine the occurrence and strength of scintillations. A well-defined diurnal variation was observed with the largest scintillation activity being seen around local midnight, as found by other authors. Around noon very little scintillation was seen. To study the latitudinal variation, 29 passes were analyzed in detail for the interval from 22.00 to 02.00 local time. In this way the diurnal variation of the latitudinal behavior was avoided. A strong increase of scintillation was seen to the north of the observing site while to the south its occurrence remained constant. At the limits of the latitude range, a considerable decrease of occurrence was observed. The same data were analyzed by considering only satellite elevation angles greater than 20°, but no important differences were observed. For the analysis of scintillation, 2 indices were defined, the relative amplitude and the rate of the scintillation fading. The behavior of these 2 indices for all elevation angles was studied. The most important observation made was that, during the interval of time under consideration, both the amplitude and rate of scintillation were high. No evidence of longitudinal variation was found. The observed latitudinal variation could be explained by a combination of an increase of scintillation activity towards the equator and a decrease of activity, both to the north and south, due to the decrease of the value of the angle between the wave propagation direction and the magnetic field line. (BBB)

9415 GENERATION OF COLLISIONLESS SHOCK WAVES PROPAGATING ALONG A MAGNETIC FIELD. Nesterikhin, Yu. E.; Ponomarenko, A. G.; Yablochnikov, B. A. (Inst. of Nuclear Physics, Academy of Sciences, USSR). JETP Lett. (USSR) (Engl. Transl.), 4: 272-6(Nov. 15, 1966).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Redaktsiyu, 4: 403-9(Nov. 15, 1966).

Preliminary results of an experimental investigation on the conditions for the excitation of shock waves propagating in a rarefied plasma along a magnetic field are presented. A column of preliminary plasma was produced in a quasistationary magnetic field H_0 = 0 to 3 kOe by discharging a capacitor through a coil in a glass vacuum chamber filled with hydrogen. The diagnostic methods and results are briefly discussed. (M.O.W.)

9416 TRANSIENT COUPLING BETWEEN MOTIONS OF PLASMA AND NEUTRALS IN THE F REGION. Barthel, James R. (Univ. of California, San Diego, La Jolla). Phys. Fluids, 9: 2540-2(Dec. 1966).

In a weakly ionized plasma, the motion of the neutrals causes induced electric fields, which result in a transient plasma drift at approximately the neutral velocity if the flow field dimension exceeds the decay length for Alfvén waves. (auth)

9417 B AND C SOURCES OF JOVIAN DECAMETRIC RADIATION. Barrow, C. H. (Florida State Univ., Tallahassee); Baart, E. E. Nature, 213: 165-6(Jan. 14, 1967).

A study of very short duration (<50 m sec.) pulses in the decametre radiation from Jupiter has been described. It seemed that this type of radiation was associated with the subsidiary B and C "sources" on Jupiter rather than with the main source A. The purpose of this communication is to point out a similar tendency in certain polarization observations as well as in the lower frequency observations of Jupiter. In the observations described, although the msec pulses all showed a definite polarization there did not appear to be any systematic tendency for either left-handed or right-handed pulses to predominate. In other words, the msec. type pulses and the left-handed polarization may be independent characteristics of the B and C sources. (UK)

9418 ELECTRON DENSITIES OF 8 TO 100 ELECTRONS CM^{-3} DEDUCED FROM ALOUETTE II HIGH-LATITUDE IONOGRAMS. Hagg, E. L. (Defence Research Telecommunications Establishment, Ottawa). Can. J. Phys., 45: 27-36(Jan. 1967).

Alouette II topside ionograms recorded at high latitudes (L ≈ 6 or greater) and high altitudes (1,500 to 3,000 km) show an interference pattern between the electron gyro and the electron hybrid resonance spikes, when the electron density at the satellite is very low. This interference pattern can be used to determine the electron number density at the satellite, to an accuracy of better than 10% when the electron density is less than about 100 electrons cm^{-3}. Preliminary results show that electron densities less than 30 electrons cm^{-3} occur over the region north of about 60°N geomagnetic latitude and that the southern boundary of the region where the very low electron densities are observed shifts south by about 8° between noon and midnight. (auth)

9419 REACTION RATES IN THE F REGION. Matuura, Nobuo (Radio Research Labs., Tokyo). Rep. Ionosphere Space Res. Jap., 20: 289-303(1966).

The rate coefficients of the chemical reactions controlling the densities of ions and electrons in the height range between 130 and 220 km were determined so that the calculated ion and electron distributions may fit to those obtained from rocket observations. The rate coefficients obtained in this way are compared with laboratory data. They show reasonable values, though the rate coefficients of O^+ removal are about one-fourth of those given by Fehsenfeld et. al. (1965). (auth)

9420 SEASONAL VARIATION IN TEMPERATURE IN THE NIGHTTIME F REGION. Okuda, Mitsunao (Tohoku Univ., Sendai). Rep. Ionosphere Space Res. Jap., 20: 304-11(1966).

The seasonal variation in the atmospheric temperature in the nighttime F region is obtained through an analysis of the observed intensity of [OI] 6300Å nightglow and the structure of the upper atmosphere proposed by Harris and Priester. The temperature variation of about 10 to 20% consists mainly of annual and semiannual components, the maximum of which appears in winter and equinox, respectively. (auth)

9421 DISCONTINUITY IN DIURNAL VARIATION OF WHISTLER DISPERSION IN LOW LATITUDE. Oguti, Takasi (Tokyo Univ.); Kokubun, Susumu; Tsuruda, Koichiro. Rep. Ionosphere Space Res. Jap., 20: 322-8(1966).

Two striking features were found in the diurnal variation of the occurrence frequency and of the dispersion value of whistlers recorded at a low-latitude station, Kakioka, in a continuous observation on 2–3 February, 1965. The one is a whistler burst of 5 hours in duration from 12h local time on Feb. 2, and the other is abrupt changes in whistler dispersion in the early morning at 02h 15m and at 06h 20m L. T. on Feb. 3. In the former abrupt change, the dispersion value changed from about 12 $sec^{\frac{1}{2}}$ to 24 $sec^{\frac{1}{2}}$, whereas in the latter event from 25 $sec^{\frac{1}{2}}$ to 18 $sec^{\frac{1}{2}}$. The former event seems to be a sudden predominant appearance of two-hop whistlers of hybrid type, and the latter would be due to a production of a new duct at the sunrise. (auth)

9422 TEMPERATURE DISTRIBUTION IN THE MAGNETOSPHERE. Tamao, Tsutomu (Tokyo Univ.). Rep. Ionosphere Space Res. Jap., 20: 312-21(1966).

Using the radial temperature profile of the magnetospheric plasma near the equatorial plane observed by IMP satellites, and assuming the stationary heat conduction along each field lines, a temperature distribution in the inner magnetosphere is obtained. In order to maintain the temperature difference between the base of the exosphere and the inner magnetosphere, it is necessary to have a large amount of energy production, 10^{-12} $ergs/cm^3$ sec, near the equatorial plane, if a stationary diffusion model along magnetic field lines is considered. From the latitudinal distribution of downward energy flux at the base (3000 km altitude) which is derived from the heat conduction model, the stationary diffusion may be limited within the region below 60° geomagnetic latitude. (auth)

9423 NON-ANTI-MATTER NATURE OF THE TUNGUSKA METEOR. Marshall, L. (Univ. of Colorado, Denver). Nature, 212: 1226(Dec. 10, 1966).

The deduction of Cowan et al. (Nature, 206: 861(1965)), from their radiocarbon measurements of tree rings, that the Tunguska meteorite could not have been made of antimatter has been called into question by Gentry (Nature, 211: 1071(1966)). The assumption of Cowan et al. that there are about 8 ± 4 neutrons per nucleon-antinucleon annihilation is supported and the validity of their conclusion is reaffirmed. (W.D.M.)

9424 POLARIZATION AND SPECTRAL DEPENDENCE OF FINE STRUCTURE IN JUPITER RADIO BURSTS. Gordon, Mark Aitken. Boulder, Colo., Univ. of Colorado, 1966. 179p.

Thesis.

The radio emission from Jupiter on a 10 msec time base within the frequency range 24 through 36 Mhz is examined. A sweep-frequency receiver produced spectra, time-concurrently, in three polarization modes: right circular, left circular, and spatially rotating linear. The instrument was operated from October 2 through December 17, 1964, in conjunction with the 1000-foot Arecibo radiotelescope. Circular feeds were synthesized from a lumped parameter quadrature hybrid ring and two linearly polarized log periodic dipole antennas. The linearly polarized mode resulted from the electrical superposition of the circularly polarized modes; the linear mode was spatially rotated by varying the phase between the two circular modes. Jupiter events appeared on 19 of 39 observing nights. The emission is classified as normal, having little or no time structure shorter in duration than tens of seconds, or structured, having fine structure in time. Of the 19 events, 3 were of the structural type, and only 1 of these 3 had extensively developed fine structure. In this event, October 17, intense narrow-band bursts were observed to drift downwards in frequency at rates of 25 to 35 Mhz/sec. In addition, a polarization diversity in frequency was evident—thereby suggesting Faraday effect in Jupiter's ionosphere. An analysis of conditions along the ray path from Jupiter to Arecibo suggests that Faraday fringes in the rotating linear spectra can be attributed to longitudinal Faraday effect in the earth's ionosphere over Arecibo or to Faraday effect at both Jupiter and Arecibo. The latter explanation explains the polarization diversity; the former does not. A combined observational and theoretical investigation of the Jupiter Faraday effect describes the emission region as having an electron density of 3×10^4/cc, a magnetic field density of 13 gauss, and negligible collision damping if the wave interaction takes place over a scale height of 20 km. It is suggested that Jupiter fine structure may result from an aperture of phase-coherent radiators and hence be related to Faraday effect. The two characteristic modes necessary for Jupiter Faraday effect may arise from coupling in Jupiter's ionosphere where the plasma frequency is nearly equal to the wave frequency. The problem of how the radiation escapes is discussed. (Dissertation Abstr.)

9425 RADIATION TRAPPED IN THE EARTH'S MAGNETIC FIELD. Proceedings of the Advanced Study Institute held at the Chr. Michelsen Institute, Bergen, Norway, August 16–September 3, 1965. McCormac, Billy M. (ed.). Astrophysics and Space Science Library. Volume V. New York, Gordon and Breach Science Publishers, 1966. 913p. $45.00. (CONF-650816–).

The various sessions include lectures on the following subjects: B–L space, particle distribution in the natural belts, sources and sinks of natural trapped radiation, physics of the outer magnetosphere, artificial injected radiation, synchrotron radiation, effects of trapped radiation on electronic devices, and radiation doses received by manned flight in the trapped radiation belts. Separate abstracts are included here for 47 papers. Seven of the papers have appeared in NSA earlier; for citations to these, see the NSA Report Number Index, CONF-650816. (J.H.M.)

For abstracts of individual lectures see: 8663, 8664, 9426–9468, 9640, and 9641.

9426 MODELS OF THE EARTH'S MAGNETIC FIELD. Cain, Joseph C. (Goddard Space Flight Center, Greenbelt, Md.). pp 7-25 of Radiation Trapped in the Earth's Magnetic Field. McCormac, Billy M. (ed.). New York, Gordon and Breach Science Publishers, 1966.

In considering the mathematical models necessary to derive the magnetic field the concept of a forecast versus a definitive field is introduced, and it is shown that both must eventually include allowance for plasma-field interactions beyond a few earth radii if the computed fields are to match the ambient field well enough to be useful in helping to understand such experimental data as those from trapped particles. Within a few earth radii, where the effect of the core field predominates, the requirements for increased accuracy may also include making allowance for ionospheric currents and, below a few tens of kilometers, estimates of the crustal field. The estimates of the core field are greatly hampered by the very irregular space–time distribution of magnetic survey data. Nevertheless, the significant spatial wavelengths in this field appear to require at least a factor of two more parameters than the 48 spherical harmonics previously used. Fitting the measured data themselves instead of data read from magnetic charts has proved a useful approach and produced fields whose errors in regions of good data coverage are only a fraction of those previously obtained. The presence of a simple external field near the earth's surface was determined but more work will need to be done to assure its reality. It is much smaller than any previous estimates but is of the correct order of magnitude to be supported by physical theory. The problems of determining or minimizing the effect of neglected parameters or of investigating the mathematical significance of the areas void of data have not yet been solved. The present fits to the core field, although containing a large number of parameters, do not appear to be significantly worse in the sparse data areas than fits using a smaller number of coefficients. In the areas of good data coverage the new field can be shown to have much smaller errors. (auth)

9427 SOME GENERAL ASPECTS OF GEOMAGNETICALLY TRAPPED RADIATION. Van Allen, J. A. (Univ. of Iowa, Iowa City). pp 65-75 of Radiation Trapped in the Earth's Magnetic Field. McCormac, Billy M. (ed.). New York, Gordon and Breach Science Publishers, 1966.

A sketch is presented of the physical principles of radiation belts, and an abridged summary of the present state of knowledge of the geomagnetically trapped radiation is included. As such, the paper is intended as an introduction to detailed papers on specific topics which constitute the remainder of the Bergen conference. (auth)

9428 LOW ALTITUDE MEASUREMENTS OF TRAPPED ELECTRONS. Imhof, W. L.; Smith, R. V. (Lockheed Missiles and Space Co., Palo Alto, Calif.). pp 100-11 of Radiation Trapped in the Earth's Magnetic Field. McCormac, Billy M. (ed.). New York, Gordon and Breach Science Publishers, 1966.

Some preliminary results on trapped electrons in the region of space near the earth's atmosphere are presented. The instrumentation is described, and the energy spectrum and longitudinal variations of the electrons are discussed. Information possibly obtainable from an extensive program of measurements on very low L shells is reviewed. (J.H.M.)

9429 SOME COSMIC RAY AND RADIATION BELT OBSERVATIONS BASED ON DATA FROM THE ANTON 302 G-M COUNTER IN ARIEL I. Elliot, H. (Imperial Coll. of Science and Tech., London). pp 76-99 of Radiation Trapped in the Earth's Magnetic Field. McCormac, Billy M. (ed.). New York, Gordon and Breach Science Publishers, 1966.

Data obtained by means of a shielded Anton 302 counter carried in Ariel I are discussed. In the direction in which the amount of absorbing material for this detector was a minimum the counter was effectively shielded by 0.73 g cm^{-2} Eccofoam, 1.13 g cm^{-2} lead, 1.01 g cm^{-2} aluminum, and 0.4 g cm^{-2} iron. Electrons with energies of 7.4 and 10.5 MeV have probabilities of direct penetration of 10 and 50% respectively. The corresponding threshold for protons is ~50 MeV. The counter also responds, but with low efficiency, to bremsstrahlung from electrons stopping in the shielding material and to γ-rays. In the latter case the efficiency is about 0.4%. The product of counter efficiency for charged particles and the omnidirectional geometrical factor is ~0.5 cm^2. Ariel I was launched on April 26, 1962, into an orbit with inclination 54°, apogee 1200 km and perigee 400 km. Included in the payload was a tape recorder capable of storing data over a complete orbit and playing it back on command. Tape recorded data from the counter are available from shortly after launch until three days after the Starfish event on July 9, 1962, when operation became intermittent following solar cell damage. When the spacecraft was outside the boundaries of the radiation belt, the counting rate of the G–M counter was expected to be due predominantly to cosmic ray protons and charged-particle albedo. If an adequate correction can be made for the albedo contribution it is possible, in principle, to derive an integral rigidity spectrum for the cosmic ray protons from the measured latitude-dependence of the counting rate. It was of interest, therefore, to compare the spectrum deduced from the G–M counter data with that of the Cherenkov counter also carried in Ariel I, which was used to detect cosmic rays with $Z > 2$ and had negligible response to albedo. (auth)

9430 RESONANCE ACCELERATION OF PARTICLES IN THE INNER RADIATION BELT. Cladis, J. B. (Lockheed Missiles and Space Co., Palo Alto, Calif.). pp 112-15 of Radiation Trapped in the Earth's Magnetic Field. McCormac, Billy M. (ed.). New York, Gordon and Breach Science Publishers, 1966.

Evidence is presented for the action of an acceleration mechanism which explains the sudden appearances of the two groups of rather monoenergetic electrons described by W. L. Imhof in a previous report. Imhof shows that oscillations of the geomagnetic field occurred at the estimated onset time of the 1.35-MeV electrons on October 29, 1963, and during the observed onset time of the 0.75-MeV electrons on November 2, 1963. Analysis of the particle data and the magnetograms indicates (1) the particles were accelerated by magnetic field variations over the western slope of the Brazilian geomagnetic anomaly which were in resonance with the longitudinal drift frequencies of the electrons, (2) the accelerating magnetic fields were produced by a periodic

modulation of local ionospheric currents, and (3) the energy gained by the electrons was sufficient to have caused them to move down L shells to the region where they were observed from higher L shells where such electrons were abundant. (J.H.M.)

9431 ENERGY SPECTRUM OF INNER ZONE PROTONS. Freden, Stanley C. (Aerospace Corp., El Segundo, Calif.). pp 116-28 of Radiation Trapped in the Earth's Magnetic Field. McCormac, Billy M. (ed.). New York, Gordon and Breach Science Publishers, 1966.

A summary of the early measurements of the proton spectra in the inner radiation zone is presented. A brief discussion is then given of the theoretical calculations which have been made to explain the measured proton spectra. Some recent data are presented in which proton spectra were measured over a wide range of B–L space from satellites, and the experimentally measured spectra are compared with the theoretical calculations. Several conclusions are drawn about the source and loss mechanisms for protons in the inner radiation zone. (auth)

9432 ELECTRON AND PROTON OBSERVATIONS. Katz, Ludwig. (Air Force Cambridge Research Labs., Bedford, Mass.). pp 129-54 of Radiation Trapped in the Earth's Magnetic Field. McCormac, Billy M. (ed.). New York, Gordon and Breach Science Publishers, 1966.

Intensities, energy spectra, and pitch angle distributions of electrons and protons in the radiation belts are discussed. Information is presented on the following: (1) results on 1- to 4-MeV electrons as observed during the fall of 1963 on a polar satellite, (2) results on 1- to 4-MeV protons obtained in a rocket flight near the equator up to L values of 3.7, and (3) results on 55-MeV protons observed periodically over a period of 4 years mirroring at the South Atlantic anomaly. (J.H.M.)

9433 TEMPORAL STABILITY OF INNER ZONE PROTONS. Pieper, George F. (Goddard Space Flight Center, Greenbelt, Md.). pp 155-64 of Radiation Trapped in the Earth's Magnetic Field. McCormac, Billy M. (ed.). New York, Gordon and Breach Science Publishers, 1966.

Experimental evidence is presented for the temporal stability of inner-zone protons as determined from measurements made with instruments aboard the satellite Injun I in the period July–December, 1961. Results indicate that trapped protons in the inner Van Allen belt in the energy ranges 1 to 15 MeV and >40 MeV were not affected by the geophysical disturbances that occurred between July and December, a period containing nine solar proton events and seventeen magnetic storms. (J.H.M.)

9434 SOME OBSERVATIONS OF THE DISTRIBUTION OF ENERGETIC PROTONS IN THE EARTH'S RADIATION BELTS BETWEEN 1962 AND 1964. Gabbe, J. D.; Brown, W. L. (Bell Telephone Labs., Inc., Murray Hill, N. J.). pp 165-84 of Radiation Trapped in the Earth's Magnetic Field. McCormac, Billy M. (ed.). New York, Gordon and Breach Science Publishers, 1966.

Flux distributions are presented for protons with energies between 4 and 13 MeV, 18 and 27 MeV, 26 and 33 MeV, 50 and 135 MeV, and 49 and 145 MeV measured from July 1962 to September 1963 at geocentric distances in the range 1.01 to 3.4 earth radii. Using data extending to June 1964, secular temporal changes are discussed, some effects of the magnetic storm of September 22, 1963 are described, and some aspects of the energy spectrum are noted. (auth)

9435 ALOUETTE SATELLITE RESULTS. Rose, D. C. (National Research Council, Ottawa). pp 191-214 of Radiation Trapped in the Earth's Magnetic Field. McCormac, Billy M. (ed.). New York, Gordon and Breach Science Publishers, 1966.

Results from the energetic particle package included in the Alouette satellite are presented. The package contained six particle detectors whose properties are shown. The information is limited to electron flux measurements in the outer belt at the satellite orbit altitude of 1000 ± 25 kilometers. Discussions are included on (1) the average behavior of intensity of the electrons, (2) the diurnal variation of the layer boundary, (3) electron spikes outside the belt, and (4) the peak intensity of the electrons. (J.H.M.)

9436 OUTER ZONE PROTONS. Davis, L. R.; Williamson, J. M. (Goddard Space Flight Center, Greenbelt, Md.). pp 215-30 of Radiation Trapped in the Earth's Magnetic Field. McCormac, Billy M. (ed.). New York, Gordon and Breach Science Publishers, 1966.

Charged particle detectors aboard satellites Explorer XII, XIV and XV have provided measurements of the intensity and spectra of 100 to 1700-keV protons in the region above two earth radii during 1961 and 1962. These results as well as those of other measurements are summarized. Additional measurements made on Explorer XXVI in February 1965 are presented and compared with the previous results. They show that: (1) between December 1962 and February 1965 the intensities of protons having energies greater than 500 keV increased by a factor of two or more over most and possibly all of the region from 2.5 to 5 earth radii, and (2) over the same region the 100- to 300-keV protons are greatly depleted in 1965. During a magnetic storm on April 18, 1965, and while Explorer XXVI was near apogee (5 earth radii) with L almost constant, the low-energy protons were observed to increase dramatically over a ten-minute period. During the same period the 10- to 100-keV electrons decreased in intensity and then over the next 30 minutes built back up with higher average energy. Two such events were observed, both coincident with high-latitude negative bays. The results indicate that the >100-keV protons are not directly related to the ring current particles. (auth)

9437 TRAPPED RADIATION ESTIMATES FOR THE OTHER PLANETS. Reiffel, L. (Illinois Inst. of Tech., Chicago). pp 256-62 of Radiation Trapped in the Earth's Magnetic Field. McCormac, Billy M. (ed.). New York, Gordon and Breach Science Publishers, 1966.

Discussions are presented on a number of topics relevant to planetary radiation belts and planetary magnetic fields. The solar system planet by planet is covered, reserving more of the commentary for Jupiter, since more reliable estimates can be made. (J.H.M.)

9438 OUTER ZONE ELECTRONS. Williams, Donald J. (Johns Hopkins Univ., Silver Spring, Md.). pp 263-83 of Radiation Trapped in the Earth's Magnetic Field. McCormac, Billy M. (ed.). New York, Gordon and Breach Science Publishers, 1966.

Results of a series of studies concerned with the observation and interpretation of the spatial and temporal behavior of high-energy ($E_e \geq 280$ keV) trapped electrons in the outer zone are reviewed. The observations were obtained at low altitude and high latitudes from the polar orbiting satellite 1963 38C. (J.H.M.)

9439 ORIGIN AND LOSS OF INNER ZONE PROTONS. Lenchek, A. M. (Univ. of Maryland, College Park). pp 287-301 of Radiation Trapped in the Earth's Magnetic Field. McCormac, Billy M. (ed.). New York, Gordon and Breach Science Publishers, 1966.

The first particles detected in the radiation belt were energetic protons near L = 1.2 (Van Allen et al., 1958). The suggestion made by Singer (1958) that the radiation consisted of protons in the 100-MeV range generated by the decay of cosmic-ray albedo neutrons seems still to be valid. The theory is able to account for observations to better than an order of magnitude. However, the region of space in which the theory works is very small, <1% of the magnetosphere. Scattering by hydromagnetic waves seems to limit stable trapping to this small region above the magnetic equator. Low-energy protons of unknown origin are superimposed on the proton belt of cosmic-ray albedo origin. (auth)

9440 PARTICLE EFFECTS IN THE GEOMAGNETIC FIELD. Parker, E. N. (Univ. of Chicago). pp 302-20 of Radiation Trapped in the Earth's Magnetic Field. McCormac, Billy M. (ed.). New York, Gordon and Breach Science Publishers, 1966.

A summary is presented of the theoretical understanding of the behavior of charged particles and plasma in the geomagnetic field. Discussions are included on (1) deformation of the geomagnetic field, (2) problems of the magnetopause, and (3) diffusion and acceleration of trapped particles. (J.H.M.)

9441 PRECIPITATION OF ELECTRONS AND PROTONS INTO THE ATMOSPHERE. O'Brien, Brian J. (Rice Univ., Houston, Tex.). pp 321-36 of Radiation Trapped in the Earth's Magnetic Field. McCormac, Billy M. (ed.). New York, Gordon and Breach Science Publishers, 1966.

In discussing the precipitation of electrons and protons, information is included on the loss cone or cone of precipitation, magnetospheric configuration, parameters of precipitation, pitch angle distribution, backscattering of precipitated particles, trapping, and auroral electrons. A comparison of fluxes of precipitated protons and electrons is given, and a short note is included on high-latitude spikes of electrons. (J.H.M.)

9442 LOSS RATES OF TRAPPED ELECTRONS BY ATMOSPHERIC COLLISIONS. Walt, Martin (Lockheed Missiles and Space Co., Palo Alto, Calif.). pp 337-51 of Radiation Trapped in the Earth's Magnetic Field. McCormac, Billy M. (ed.). New York, Gordon and Breach Science Publishers, 1966.

The role of atmospheric collisions on the long-term behavior of electrons in the radiation belts is evaluated. The effect of atmospheric collisions on electron distributions is discussed. Theoretical values of the electron flux produced by the high-altitude nuclear detonation on July 9, 1962, are plotted. A com-

parison of theoretical and experimental values for the time variation of the trapped electron flux resulting from the Starfish high-altitude nuclear explosion is included. Also given are decay rates as function of magnetic shell L, decay time constants at low L values, and the spectrum of the electron source in the lower part of the inner radiation belt. (J.H.M.)

9443 SOURCE OF OUTER ZONE PROTONS. Hess, Wilmot N. (Goddard Space Flight Center, Greenbelt, Md.). pp 352-68 of Radiation Trapped in the Earth's Magnetic Field. McCormac, Billy M. (ed.). New York, Gordon and Breach Science Publishers, 1966.

In the range L = 2 to 5 in the outer radiation belt, it was found that the spectra of the relatively stable 0.1- to 5-MeV protons show smooth but large variations with L and equatorial pitch angle. This is shown in Explorer XII data plotted of low-energy proton spectra at various distances from the earth. Kellogg (1959) suggested that the radiation belt might be formed through magnetic disturbances in which the third adiabatic invariant of trapped particles is violated without violating the first and second invariants. Violation of the third invariant allows motion in L space. As particles move closer to the earth they tend to gain energy with the maintenance of the first invariant. This process can introduce acceleration of protons. Kellogg's suggestion has been adopted for this study. (J.H.M.)

9444 DIFFUSION OF PROTONS IN THE OUTER RADIATION BELT. Nakada, M. P.; Mead, G. D. (Goddard Space Flight Center, Greenbelt, Md.). pp 369-72 of Radiation Trapped in the Earth's Magnetic Field. McCormac, Billy M. (ed.). New York, Gordon and Breach Science Publishers, 1966.

Previous analyses of the diffusion mechanism of protons in the outer radiation belt are reviewed. Solutions were obtained for the Fokker–Planck equation containing terms describing energy losses due to Coulomb interaction with the ambient electrons, as well as charge exchange losses with the neutral atmosphere; these are briefly discussed. To obtain a numerical value for the diffusion coefficient in the Fokker–Planck equation, an estimate was used of the actual number of observed sudden impulses and commencements of various amplitudes during the period 1958 to 1961. Resulting theoretical curves compared with experimental fluxes are shown. The present analysis suggests that the source of the outer-belt protons is near the magnetopause and that some process that violates the third adiabatic invariant is important in moving protons into the region of the outer radiation belt. The similarity of the calculated fluxes to measurements gives support to the idea that some diffusion process is important. (J.H.M.)

9445 LONGITUDE DEPENDENCE OF GEOMAGNETICALLY TRAPPED ELECTRONS. Roederer, Juan G. (Goddard Space Flight Center, Greenbelt, Md.); Welch, Jasper A. pp 373-7 of Radiation Trapped in the Earth's Magnetic Field. McCormac, Billy M. (ed.). New York, Gordon and Breach Science Publishers, 1966.

A method is described for calculating the longitude dependence of geomagnetically trapped electrons at low altitude on the basis of scattering and energy loss due to atmospheric interactions. (auth)

9446 OBSERVATION OF IONOSPHERIC EFFECTS DUE TO DUMPING OF TRAPPED PARTICLES. Gassmann, G. J. (Air Force Cambridge Research Labs., Bedford, Mass.); Pike, C. P. Jr. pp 378-85 of Radiation Trapped in the Earth's Magnetic Field. McCormac, Billy M. (ed.). New York, Gordon and Breach Science Publishers, 1966.

Energy considerations lead to the conclusion that the Van Allen belts feed sizable amounts of ionizing energy into the ionosphere by precipitation of particles. Most suspicious, although not clearly unique in importance, are the western slopes of the magnetic anomalies and their conjugate areas. A map of prospective dumping areas of electrons due to longitudinal drift is presented. The results from thirteen airborne measurements in an area conjugate to the suspected South Atlantic dumping area are presented. Vertical ionospheric recordings during a number of nights of magnetically quiet periods have been analyzed in search for local effects. Up to nine observations per location, obtained at various different local times, were averaged. The echo amplitudes show no local effect recognizable on top of the expected temporal fluctuations. A distinct local effect, however, in a large area centering 1000 km north of Puerto Rico and probably extending to the east consisted of low values of f_{max} E_{s-f} relative to those at other areas covered. (auth)

9447 SURVEY OF ACCELERATION AND DIFFUSION. Dungey, J. W. (Imperial Coll. of Science and Tech., London). pp 389-97 of Radiation Trapped in the Earth's Magnetic Field. McCormac, Billy M. (ed.). New York, Gordon and Breach Science Publishers, 1966.

Information on trapped particle acceleration under adiabatic and nonadiabatic conditions is surveyed with emphasis on the static field problem. A discussion is included on the association of auroral substorms with the magnetosphere and their relation to the electric field in the tail region. Information on diffusion processes in general is reviewed, and general properties of bounce resonance are also included. (J.H.M.)

9448 COEFFICIENTS OF DIFFUSION IN THE OUTER RADIATION BELT. Faelthammar, Carl-Gunne (Royal Inst. of Tech., Stockholm). pp 398-402 of Radiation Trapped in the Earth's Magnetic Field. McCormac, Billy M. (ed.). New York, Gordon and Breach Science Publishers, 1966.

General expressions for the diffusion coefficients due to electric and magnetic disturbances that can contribute to the transport of particles are summarized. Equations that reduce the problem of computing diffusion coefficients are given. Values of the azimuthal drift period in the equatorial plane of the earth's magnetic dipole field are plotted. (J.H.M.)

9449 OBSERVATIONS OF MAGNETOSPHERIC BOUNDARY PHENOMENA. Frank, L. A. (Univ. of Iowa, Iowa City). pp 422-46 of Radiation Trapped in the Earth's Magnetic Field. McCormac, Billy M. (ed.). New York, Gordon and Breach Science Publishers, 1966.

Results of a collection of experimental data concerning phenomena in the earth's outer magnetosphere and its immediate vicinity are discussed. Illustrations are shown of the solar ecliptic coordinate system and of the solar magnetospheric coordinate system. Experimental observations concerning the topology of magnetic fields are summarized, and observations of charged particles in the distant geomagnetic field are discussed. (J.H.M.)

9450 MAGNETOSPHERIC MODELS. Dessler, A. J.; Michel, F. C. (Rice Univ., Houston, Tex.). pp 447-56 of Radiation Trapped in the Earth's Magnetic Field. McCormac, Billy M. (ed.). New York, Gordon and Breach Science Publishers, 1966.

Several magnetospheric models are compared and checked against available experimental data. No evidence is found to support the hypothesis of fast magnetic merging (or annihilation of magnetic energy) and neutral line formation. It is concluded that the concept of fast magnetic merging plays no significant role either in determining the configuration of the magnetosphere or in the acceleration of charged particles within the magnetosphere. (auth)

9451 NATURE OF THE OUTER MAGNETOSPHERE AND THE MAGNETOPAUSE THEORY. Beard, David (Univ. of Kansas, Lawrence). pp 457-80 of Radiation Trapped in the Earth's Magnetic Field. McCormac, Billy M. (ed.). New York, Gordon and Breach Science Publishers, 1966.

Theoretical discussions, calculations, and illustrations concerning the magnetosphere and magnetopause are presented. Information is included on the following: (1) solar wind compression of the geomagnetic field, (2) particle trajectories at the boundary, (3) charged particle trajectories in a boundary layer between a plasma and a magnetic field, (4) deflection of interplanetary field lines by the magnetosphere when the lines are parallel to the solar wind velocity, (5) particle orbit when a weak magnetic field is imbedded in the plasma incident on a strong stationary magnetic field, (6) particle orbits when the surface is a cylinder instead of a plane, (7) magnetic field lines and intersections of the magnetospheric boundary, (8) contours of the magnetospheric boundary, and (9) electron and proton trajectories traveling with a magnetic field which is slowed down and compressed downstream from the shock boundary. (J.H.M.)

9452 MOTION OF TRAPPED PARTICLES IN A DISTORTED FIELD. Mead, Gilbert D. (Goddard Space Flight Center, Greenbelt, Md.). pp 481-90 of Radiation Trapped in the Earth's Magnetic Field. McCormac, Billy M. (ed.). New York, Gordon and Breach Science Publishers, 1966.

The motion of charged particles in a geomagnetic field distorted by the solar wind is examined, using adiabatic theory. It is shown that the drift motion of particles trapped on high L-shells depends strongly on their equatorial pitch angle. Those mirroring near the equator move in on the night side, while those mirroring at low altitudes move out, thus producing a significant splitting of the L shell with pitch angle. One consequence is that the very high latitude lines on the day side may contain trapped particles near the equator, but none near the ends of the lines. The opening up of field lines in the geomagnetic tail may be the controlling factor governing the high-latitude limit of trapping on both the day side and the night side. (auth)

9453 SOME PLASMA INSTABILITIES OF THE MAGNETOSPHERE. Chang, David B. (General Atomic Div., General

Dynamics Corp., San Diego, Calif.). pp 491-503 of Radiation Trapped in the Earth's Magnetic Field. McCormac, Billy M. (ed.). New York, Gordon and Breach Science Publishers, 1966.

Four plasma instabilities which may operate in planetary magnetospheres are described: (1) the low-frequency Rayleigh–Taylor-type flute instability as affected by a resistive ionosphere, a dipole field geometry and by resonant particle-wave interactions; (2) a whistler instability, with the concomitant particle diffusion, which occurs in a plasma containing a small component of flat-helix energetic electrons; (3) a nonconvective high-frequency two-energy component electrostatic loss-cone instability; and (4) the resistive instabilities occurring in sheared magnetic fields, as affected by the Chapman and Cowling collisional and magnetic viscosities and Hall currents. (auth)

9454 AURORAL PHENOMENA ASSOCIATED WITH PARTICLE PRECIPITATIONS. Maehlum, Bernt (Norwegian Defence Research Establishment, Kjeller). pp 504-37 of Radiation Trapped in the Earth's Magnetic Field. McCormac, Billy M. (ed.). New York, Gordon and Breach Science Publishers, 1966.

Ground based observations of upper atmosphere phenomena at high latitudes associated with particle precipitation are reviewed. The main effects of these particles in the earth's atmosphere which may be observed from the ground are: (1) ionization, (2) excitation, and (3) heating of the air atoms/molecules. The two former of these effects are covered, mainly. From the height profile of the free electron density and auroral luminosity semiquantitative results on the energy distribution of the primary particles may be drawn. The horizontal distribution of auroral phenomena, on the other hand, provides information on the spatial distribution of the particles. Upper atmospheric heating due to bombardment of fast particles has not yet been thoroughly studied. In a bright aurora each air molecule gains a thermal energy of some 20 μeV/sec (Chamberlain, 1961) which is sufficient for a significant enhancement of the temperature within a few minutes. Sporadic temperature enchancements of many hundred degrees were observed in the upper atmosphere at high latitudes (Blamont and Chanin-Lory, 1965; Krassovsky, 1965). It is still an open question whether these increases in the air temperature may be ascribed to direct particle bombardment, or whether Joule heating due to auroral associated current systems is the main source (Kato, 1962; Cole, 1962). It is however, clear that temperature measurements are very important for investigations of the auroral phenomena and for the particle physics generally. (auth)

9455 IONOSPHERIC RESPONSE TO PARTICLE PRECIPITATION BY f_{min}-BLACKOUT TECHNIQUE. Stolov, Harold L. (Goddard Inst. for Space Studies, New York). pp 538-46 of Radiation Trapped in the Earth's Magnetic Field. McCormac, Billy M. (ed). New York, Gordon and Breach Science Publishers, 1966.

Using the f_{min}-blackout method of studying auroral absorption, data from over 50 ionosonde stations in the northern hemisphere are analyzed during the geomagnetic storm with SC 0810 UT on October 28, 1961. Injun I energetic particle measurements are available during the main phase. It is demonstrated that auroral absorption is present on both sides of the high-latitude boundary of the trapping region for electrons greater than 40 keV. The increased auroral absorption observed during the morning hours is apparently associated with the increased precipitation of energetic electrons during the morning hours reported by several investigators. Large fluxes of electrons with energies between 10 and 40 keV, reported north of the 40-keV boundary, and the associated auroral absorption observed north of the boundary suggest that the high-latitude trapping boundary for 10-keV electrons might be at a greater latitude than the high-latitude trapping boundary for 40-keV electrons. Ionospheric responses to isolated high-latitude spikes of 40-keV electrons have not yet been detected. (auth)

9456 TAIL OF THE MAGNETOSPHERE AND PARTICLE ACCELERATION. Hoh, F. C. (Boeing Co., Seattle). pp 547-50 of Radiation Trapped in the Earth's Magnetic Field. McCormac, Billy M. (ed.). New York, Gordon and Breach Science Publishers, 1966.

A short version is presented of an earlier paper by the author (1965) with emphasis on some of the questions which arose after the presentation. A magnetic field configuration on the night side of the earth measured by the IMP satellite is shown. A sheet pinch model and particle acceleration mechanisms including types of particle motion are discussed. The relation of the acceleration mechanism to the instability of sheet is included. (J.H.M.)

9457 FLUID MODEL FOR THE INTERACTION OF THE SOLAR WIND AND THE GEOMAGNETIC FIELD. Spreiter, John R.; Summers, Audrey L.; Alksne, Alberta Y. (Ames Research Center, Moffett Field, Calif.). pp 551-62 of Radiation Trapped in the Earth's Magnetic Field. McCormac, Billy M. (ed.). New York, Gordon and Breach Science Publishers, 1966.

A method is presented for obtaining results for the magnetosphere boundary, the bow wave, and the associated flow field from a fluid point of view without resorting to a mixture of particle and fluid models as usually employed. Numerical results are given for the flow parameters in the shock layer between the bow wave and the magnetosphere boundary. The object is to analyze the properties of the solar wind as it flows steadily through the bow wave and around the forward portion of the magnetosphere. (J.H.M.)

9458 SPATIAL DISTRIBUTION AND TIME DECAY OF THE INTENSITIES OF GEOMAGNETICALLY TRAPPED ELECTRONS FROM THE HIGH ALTITUDE NUCLEAR BURST OF JULY 1962. Van Allen, J. A. (Univ. of Iowa, Iowa City). pp 575-92 of Radiation Trapped in the Earth's Magnetic Field. McCormac, Billy M. (ed.). New York, Gordon and Breach Science Publishers, 1966.

A one-year observational study of the artificial radiation belt produced by the nuclear burst Starfish on July 9, 1962, is reported. It is estimated that 1.3×10^{25} electrons from radioactive fission products, or some 2.6% of the total yield, were present in geomagnetically trapped orbits at 10 hours after the burst. These electrons disappeared in the manner expected from the atmospheric loss theory of Walt for values of the magnetic shell parameter $L < 1.25$ earth radii. At increasing values of L the rate of disappearance was progressively more rapid than expected by this theory. The maximum observed value of the apparent mean lifetime of ~2 MeV electrons in the time range $4000 < \Delta t < 10{,}000$ hours was 2 years at $L = 1.5$. About 15% of the initially injected electrons (or 0.4 of 1% of the total) survived the first 5½ months, about 10% the first year. Detailed spatial distribution and temporal data are given in a series of plots. (auth)

9459 MEASUREMENTS OF TRAPPED ELECTRON INTENSITIES MADE BY THE EXPLORER XV SATELLITE. McIlwain, C. E. (Univ. of California, San Diego, La Jolla). pp 593-609 of Radiation Trapped in the Earth's Magnetic Field. McCormac, Billy M. (ed.). New York, Gordon and Breach Science Publishers, 1966.

The spatial distributions of three categories of trapped particles were observed for three months by two detectors on the Explorer XV satellite. The decay time constants for electrons with energies greater than 0.5 MeV were generally greater than 6 months in the region $L < 1.7$ earth radii. The corresponding time constants for electrons with energies greater than 5 MeV were unobservably long (greater than one year). On November 5, 1962, over one percent of the electrons available from the July 9, 1962, event were still present. (auth)

9460 OBSERVATIONS OF THE TRANSIENT BEHAVIOR OF ELECTRONS IN THE ARTIFICIAL RADIATION BELTS. Brown, W. L. (Bell Telephone Labs., Inc., Murray Hill, N. J.). pp 610-33 of Radiation Trapped in the Earth's Magnetic Field. McCormac, Billy M. (ed.). New York, Gordon and Breach Science Publishers, 1966.

Observations of the artificial belts of energetic electrons and their transient decay following the U. S. and U. S. S. R. nuclear tests of 1962 were made by instruments on the Telstar I and II, Relay I and II, and Explorer XV and XXVI satellites. Interesting results from these experiments were obtained on Telstar I and Explorer XV which were advantageously in orbit at times of major activity during the testing period. Their observations are described, and some observations made by Relay II long after the creation of the artificial radiation belts are discussed. All the measurements were made with a silicon diffusion p-n junction device with a sensitive volume about 2 mm in diameter and 0.4 mm in thickness. Data include information on electron distributions and decay times following the starfish burst and new particles and electron distributions from the U. S. S. R. tests. (J. H. M.)

9461 OVERALL ANALYSIS OF EXPERIMENTS ON ARTIFICIAL RADIATION BELTS. Walt, Martin (Lockheed Missiles and Space Co., Palo Alto, Calif.). pp 666-70 of Radiation Trapped in the Earth's Magnetic Field. McCormac, Billy M. (ed.). New York, Gordon and Breach Science Publishers, 1966.

Data obtained from the nuclear explosions of 1958 and 1962 are summarized. Information is included on trapped radiation from the Argus, starfish, and Russian bursts. (J.H.M.)

9462 MOTION OF BOMB DEBRIS FOLLOWING THE STARFISH TEST. Zinn, John; Hoerlin, Herman; Petschek, Albert G. (Los Alamos Scientific Lab., N. Mex.). pp 671-92 of Radiation Trapped in the Earth's Magnetic Field. McCormac, Billy M. (ed.). New York Gordon and Breach Science Publishers, 1966.

Theoretical computations are presented which identify some of

the more important processes affecting the debris expansion following the Starfish explosion. A MHD shock wave is formed, through which the moving debris and air plasma is coupled to stationary plasma. The major component of the stationary plasma is produced by the explosion through ionization of neutral air by x rays and by collisions. The detailed behavior of a model MHD shock system with collisional effects is studied by means of a Lagrangian computer program, and the computed results are compared with photographic data. The data and computations are in good qualitative agreement as to the behavior of the downward and east–west expansion. The upward expansion is slowed partly by the processes mentioned, but it is ultimately stopped and reversed through the action of conduction currents flowing in the F1 layer in a region connected to the moving plasma by way of the field lines. The observed motion of the plasma along the field lines is not correctly predicted by the machine code in its present form. The major source of electron injection at high altitudes was through a jet of plasma directed initially along the field lines toward the south. This jet was concentrated to an extent sufficient to permit it to move in a straight line across the bending B field without deflection, through leaving a trail of ionized material which was guided by the field to the southern conjugate and other points further south. The trail of the jet is quite clearly seen in the photographs. Its observed motion upward and to the west is interpreted in accordance with well known principles governing the motion of a dilute plasma in a nonuniform field. (auth)

9463 ENERGETIC ELECTRONS FROM SHOCK HEATING IN THE EXOSPHERE. Colgate, Stirling A. (New Mexico Inst. of Mining and Tech., Socorro). pp 693-700 of Radiation Trapped in the Earth's Magnetic Field. McCormac, Billy M. (ed.). New York, Gordon and Breach Science Publishers, 1966.

A significant fraction of the artificial radiation belt formed by the July 9, 1964, Starfish high-altitude nuclear explosion may have been caused by electrons heated in a magnetohydrodynamic shock wave — accelerated in the density gradient of the earth's atmosphere. Calculation of the expected fission beta electron flux from the measured fission debris decaying in transit to the southern conjugate region agrees well with the observed low L value (1.22-1.32) measurements of Injun I satellite. The measurements (Telstar) of the electron flux at higher L do not agree with the observed southern conjugate debris. The shock-injected electrons are predicted to be more than sufficient to account for the discrepancy, but there remains a major uncertainty in shock-dissipation (electron heating) mechanisms. (auth)

9464 SYNCHROTRON RADIATION MEASUREMENTS NEAR THE MAGNETIC EQUATOR. Ochs, Gerard R. (National Bureau of Standards, Boulder, Colo.). pp 703-13 of Radiation Trapped in the Earth's Magnetic Field. McCormac, Billy M. (ed.). New York, Gordon and Breach Science Publishers, 1966.

The radiation produced in the radio spectrum by relativistic electrons injected into trapped orbits in the earth's magnetic field at the time of the Starfish nuclear explosion of July 9, 1962, was monitored near Lima, Peru, for one year at 30 Mc and almost three years at 50 Mc. After an initial brief transient increase of 4.5×10^{4}K, the excess antenna temperature at 50 Mc rapidly decreased to 1×10^{4}K. Later, the temperature T_{50} at a time t days after the explosion approximately followed the law, $T_{50} = 4600\ e^{-(t/270)}$, for t > 90 days. At 30 Mc, the initial transient increase was not observed, but the subsequent behavior was similar. The decay was more rapid and the early signal was of greater intensity, however. After the first three months, the temperature T_{30} approximately followed the law, $T_{30} = 16000\ e^{-(t/180)}$. (auth)

9465 THEORETICAL MODEL OF SYNCHROTRON RADIATION AND COMPARISON WITH OBSERVATIONS. Peterson, Allen M. (Stanford Research Inst., Calif. Stanford Univ., Calif.); Hower, Glen L. pp 714-54 of Radiation Trapped in the Earth's Magnetic Field. McCormac, Billy M. (ed.). New York, Gordon and Breach Science Publishers, 1966.

The characteristics of the process of synchrotron emission from high-energy electrons spiraling in a magnetic field are reviewed. General techniques for computing numerical results are presented and the effects of the various parameters are studied graphically. (J.H.M.)

9466 METHOD FOR CALCULATION OF AVERAGE RADIATION FLUXES ON SATELLITES. Sowle, D. H.; Lowen, R. W. (General Dynamics/Convair, San Diego, Calif.). pp 808-14 of Radiation Trapped in the Earth's Magnetic Field. McCormac, Billy M. (ed.). New York, Gordon and Breach Science Publishers, 1966.

A method of calculating the time averaged flux on a satellite in orbit in the lower radiation belt (altitude $\lesssim$ 9000 km) is described. The flux encountered by a satellite is shown to converge rapidly to the average value. The deviation from the calculated average for a satellite whose period is commensurate with that of the earth is shown to be unimportant for design applications. (auth)

9467 PREDICTIONS AND OBSERVATIONS FOR SPACE FLIGHT. Adams, Duane A. (Air Force Weapons Lab., Kirtland AFB, N. Mex.); Mar, Brian W. pp 817-45 of Radiation Trapped in the Earth's Magnetic Field. McCormac, Billy M. (ed.). New York, Gordon and Breach Science Publishers, 1966.

Comprehensive shielding methods are available to predict the dose from radiation which penetrates a space vehicle. These methods are integrated with trajectory and environment definitions to predict the dose to humans in space. The contribution of solar-particle event and cosmic radiation to the total dose is predicted. Measurements of dose on the Gemini GT-4 flight and on unmanned satellites are reported. The human response to radiation must be better defined before the radiation hazard to manned space flight can be fully assessed. (auth)

9468 MODEL PROTON ENVIRONMENT ABOVE 4 MeV. Vette, James I. (Aerospace Corp., El Segundo, Calif.). pp 865-74 of Radiation Trapped in the Earth's Magnetic Field. McCormac, Billy M. (ed.). New York, Gordon and Breach Science Publishers, 1966.

The procedure for constructing a proton environment from existing satellite data is described. Four different flux maps are given to describe the 4–15, 15–30, 30–50 and above 50-MeV energy ranges. In each of these energy ranges an exponential energy spectrum is used and the variation of the spectrum with position is taken into account. A comparison of the model environment with experimental data is presented and the results of orbital integrations are shown. (auth)

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Refer also to abstracts 8647, 9092, and 9646.

9469 (AD–641992) STUDIES OF FILMS IN THE SUPERCONDUCTIVE AND NORMAL PHASES. Final Report No. 16, July 1, 1962–June 30, 1966. Serin, Bernard (Rutgers–The State Univ., New Brunswick, N. J. Dept. of Physics). Nov. 1966. Contract DA 36-039 SC-90821. 9p. (ECOM-90821-F). CFSTI $3.00 cy, $0.65 mn.

A narrative account is given of the work under this contract. Included is: (1) A study of the current carrying capacity of double layer films consisting of two different superconductors. It was demonstrated that after aging these can show limiting current density vs. magnetic field curves similar to those of hard superconductors and that the current is carried at the interface between the films where intermetallic reactions can occur. (2) An experimental verification of the theory that in superconducting films in a magnetic field perpendicular to the plane of the film, the magnetic flux is in the film in the form of quantized fluxoids. (3) A detailed study of problem (2) with alloy films of varying composition. The data were used to find how the temperature variation of the Ginzburg-Landau parameter changed with film composition. The data show qualitative disagreement with recent theoretical derivations of this temperature dependence. (4) Studies of the thermal conductivity of films. These permit a more accurate determination of the electronic component of the thermal conductivity in the superconducting state. More recently measurements have been made in a magnetic field, which produces "gapless" superconductivity. (auth)

9470 (NP–16457) SOME HYDRODYNAMIC ASPECTS OF SUPERFLUID HELIUM. Report No. 85-36. Hsieh, Din-Yu (California Inst. of Tech., Pasadena. Div. of Engineering and Applied Science). Dec. 1966. Contract N00014-67-0094-0009. 42p.

A brief critical survey on the hydrodynamic formulations of the superfluid helium is given. For the irreversible process, three major formulations, i.e. those due to Gorter–Mellink, Lin, and Hall–Vinen, Bekarevitch–Khalatnikov, are described, discussed and compared. Some results of analyses based on the Gorter–Mellink formulation are presented. Findings resulting from the assumption that rotons are vortex rings are included. (auth)

9471 (TID–23482) THE PERFORMANCE OF SMALL SUPERCONDUCTING COILS. Laverick, C. (Argonne National Lab., Ill.). Dec. 15, 1963. Contract W-31-109-eng-38. 30p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Interim information resulting from an unfinished study of the transition characteristics of small NbZr coils is reported. The effects on the transition current of rate of current increase, thermal environment, temperature changes, wire composition,

copper plating and copper cladding of the NbZr wire, and variations in coil-construction materials have been studied for Nb 25%Zr and Nb33%Zr wires. The studies have been mainly confined to the low-field region below 30 kG. (auth)

9472 QUANTUM CELL MODEL FOR He II AT NONZERO TEMPERATURE. Knollman, G. C. (Lockheed Palo Alto Research Labs., Palo Alto, Calif.). Can. J. Phys., 44: 2775-87 (Nov. 1966).

A previous quantum cell-model development is expanded to treat the solid–superfluid phase transition and the zero-momentum occupation at temperatures other than absolute zero. Application is made to liquid He(II), which is studied at various pressures out to temperatures of about a degree absolute. The effective repulsive energy, along the solid–superfluid transition, is determined for pairs of ^{4}He atoms localized in cells of volume equal to the specific volume. (auth)

9473 ANISOTROPY OF THE ENERGY GAP IN SUPERCONDUCTING LEAD–BISMUTH ALLOYS. Campbell, C. K. (McMaster Univ., Hamilton, Ont.); Dynes, R. C.; Walmsley, D. G. Can. J. Phys., 44: 2601-4(Nov. 1966).

Tunneling techniques were applied to a study of the remanent anisotropy of the energy gap in superconducting Pb–Bi alloys. The relationship between anisotropy and mean free path L is discussed for situations in which L is well inside the "dirty" superconductor limit ($L \sim \xi_0$). (auth)

9474 MICROWAVE SURFACE RESISTANCE OF TYPE II SUPERCONDUCTORS. Gilchrist, J. le G. (Cambridge Univ., Eng.). Proc. Roy. Soc. (London), Ser. A, 295: 399-420(Dec. 20, 1966).

An experiment has been performed to investigate the mixed state of type II superconductors by simultaneously measuring the real part of the surface impedance at 1.2 Gc/s and the magnetization. The surface resistance could thus be related to the magnetic condition of the specimen both during the initial magnetization and afterwards. The specimens were in the form of 1.6 mm diameter wires wound into helices and the steady field was applied parallel to the axis of the helix. In the first place tin–indium alloys having 0 to 7 at. % of indium were used, and most of the data were obtained with this alloy system. Lead alloys were used later. The results differ from those of Rosenblum et al., who worked at 23 Gc/s, in that the surface resistance was found to be sensitive to the surface condition of the specimen. But consistent results were obtained when the specimens had been chemically or electrolytically polished and a comparison is made between the data at the two frequencies. Expressed as a fraction of its value in the normal state the surface resistance at 1.2 Gc/s is found to obey the same universal function of field and temperature as at the higher frequency when allowance is made for the difference in geometrical arrangement. It is argued that the pinning mechanisms which prevent flux lines moving in response to a small direct current are unlikely to be effective in preventing high frequency oscillations. Microwave power will therefore be absorbed in the specimen owing to the damping of flux line motion by the same viscous force which is held to account for the dc resistivity when the current is large enough to overcome the pinning. The microwave surface resistance should therefore be closely related to the dc resistivity of an ideal type II superconductor with no pinning centers. In this way most of the features of the microwave data are explained qualitatively but a surface resistance is predicted which in fields much weaker than the upper critical field is larger than the experimental value. (auth)

9475 LOCAL EQUATIONS OF ELECTRODYNAMICS FOR LONDON-TYPE SUPERCONDUCTORS. Galaiko, V. P. (Kharkov State Univ.). Fiz. Metal. Metalloved., 21: 496-509(Apr. 1966). (In Russian).

In a maximally hard superconductor, the structure of the vortex filaments in the hybrid state does not play any substantial part at fields which are not too close to H_{c2}. This confirms the possibility of using local equations of electrodynamics for describing such superconductors. It is shown by means of direct calculations that the indicated equations in the first nonvanishing approximation in terms of parameter $1/\chi$ coincide with equations of the two-liquid model in the theory of superconductivity. These equations are used to analyze the problem of penetration of a magnetic field into a massive superconductor. The critical field H_{c1} up to which the superconducting state is stable with respect to slight gap fluctuations leading to the formation of vortices was calculated. The manner in which the hybrid state is described by these equations is discussed. (ATD)

9476 FLUCTUATIONS AND JUMPS OF FLUX IN SUPERCONDUCTING SOLENOIDS. Prekul, A. F.; Volkenshtein, N. V. Fiz. Metal. Metalloved., 21: 639-40(Apr. 1966). (In Russian).

It is known that flux jumps in specimens of superconducting material placed in an external magnetic field occur only in a certain definite region of a magnetic field, whereas in superconducting coils under self-excitation conditions they are observed up to the transition to the normal state. This effect was investigated in coils made of 65 BT conductor. The coil being studied was placed in a practically homogeneous magnetic field of a large superconducting solenoid. In the case of the coil placed in the external field, small-amplitude fluctuations of magnetic flux begin in fields of 200 to 300 Oe; as the magnetic field increases further, the number and duration of the fluctuations decrease. In the case of self-excitation conditions, the pulses are of the same form as in the preceding case, but are observed up to the transition to the normal state. At certain values of the current in the coil, jumps which are huge in amplitude and duration (e. g., 250 msec) appear. The variation of the characteristic H = H(I) on the axis of a large solenoid in the presence of the coil being studied was investigated. It is concluded that large flux jumps are due to the appearance of a metastable region of finite resistance in the material of the coil. (ATD)

9477 TUNNEL CURRENT FROM SUPERCONDUCTOR OF THE SECOND GROUP TO NORMAL METAL. Gogadze, G. A. Ukr. Fiz. Zh., 11: 1307-10(1966). (In Ukrainian).

A tunnel current from a massive superconductor of the second group to normal metal, when the magnetic field is perpendicular to the contact surface, is considered. In displacements less than Δ_0 ($2\Delta_0$ is the maximum value of the gap for the mixed state) a current caused by the existence of Abrikosov's vortices should flow through the tunnel structure. The asymptotics of the calculated expression dj_{NS}/dV permits investigating the region of volt–ampere characteristics near the edge of the superconductor gap. (auth)

9478 INFLUENCE OF THE SPIN CURRENT ON THE MEISSNER EFFECT. Tekiel, P. (Univ., Wroclaw). Bull. Acad. Pol. Sci., Ser. Sci. Math. Astron. Phys., 14: 573-5(1966).

The influence of the spin current on the Meissner effect in superconductors of the London and Pippard types at temperature T = 0 is investigated by means of approximate second quantization methods (A.S.Q.). The electrodynamics of the superconducting state is considered by means of the A.S.Q. method and the expression is given for the current of elementary excitations with parallel spins (spin current). The influence of spin current on the Meissner effect is investigated in some approximation. (W.D.M.)

9479 SUPERCONDUCTING SOLENOIDS FROM NIOBIUM AND ZIRCONIUM ALLOYS. Karasik, V. R.; Kurganov, G. B.; Ershov, V. G.; Shebalin, I. Yu.; Kopylovskii, B. D.; Ivanov, V. S. pp 101-9 of Metallovedenie i Metallofizika Sverkhprovodnikov. Savitskii, E. M.; Baron, V. V. (eds.). Moscow, Izdatel'stvo Nauka, 1965. (In Russian).

Solenoid tests were conducted at 4.2°K in standard glass cryostats and in a specially designed metallic cryostat. The solenoid was suspended inside the cryostat on a thin-walled stainless steel tube. Feeding current was passed through hermetic feedins, soldered into the cover, with the help of 2-mm-dia copper wires. Under the cover, the copper wires were soldered to a lead one of the same diameter, leading to the solenoid. Three forms of contacts are described. The experimental arrangement is given. More than ten solenoids were made and tested. (M.H.R.)

9480 METALLIC CRYOSTATS FOR SUPERCONDUCTING SOLENOIDS. Fradkov, A. B. pp 110-14 of Metallovedenie i Metallofizika Sverkhprovodnikov. Savitskii, E. M.; Baron, V. V. (eds.). Moscow, Izdatel'stvo Nauka, 1965. (In Russian).

The design and testing of solenoids with devices for drawing out most of the magnetic energy discharged with the superconducting to normal transition are described. (M.H.R.)

9481 PROCEDURE FOR MEASURING THE CRITICAL PARAMETERS OF SUPERCONDUCTORS FOR ALTERNATING CURRENT. Ershov, V. G.; Karasik, V. R. pp 130-1 of Metallovedenie i Metallofizika Sverkhprovodnikov. Savitskii, E. M.; Baron, V. V. (eds.). Moscow, Izdatel'stvo Nauka, 1965. (In Russian).

The instrumentation and experimental procedure are described for measuring the critical current at 140 kHz and its dependence on the fixed external magnetic field of wire specimens of 50% Nb–50% Zr alloy. The specimen is wound on a Teflon form and is connected as the coil in an LC circuit. For some voltage across the circuit the current through the specimen reaches the critical value, and a sharp voltage drop is observed. A superconducting solenoid, described in a preceding article, is used to create the external magnetic field. The measured dependence of the critical current density at 140 kHz on the magnetic field for a 150 μ diameter specimen is presented graphically. It is noted that no dependence of the critical current density on the wire specimen diameter (in the range 150 to 230 μ) was observed. Utilization of measurements of the quality factor of the LC circuit by the method of free oscillation attenuation is also described. (ATD)

9482 EFFECT OF DELAY ON THE FORM OF THE TUNNEL CHARACTERISTICS OF SUPERCONDUCTORS. Ivanchenko, Yu. M. (Donets Physico-Technical Inst., Academy of Sciences, Ukrainian SSR). JETP Lett. (USSR) (Engl. Transl.), 4: 242-4 (Nov. 1, 1966).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Redaktsiyu, 4: 358-61(Nov. 1, 1966).

Yanson, Svistunov, and Dmitrenko [1] (JETP, 47: 2091(1964) and Soviet Phys. JETP, 20: 1404(1965)) observed in an Sn–Sn tunnel structure current peaks at a barrier voltage $v = 2\Delta/n$ (n-integer, Δ-energy gap). A similar phenomenon was observed recently by Marcus in a Pb–Pb structure [2] (Phys. Letters, 19: 623(1966)). In tunnel junctions of the same type as in [2], Rochlin and Douglass [3] (Phys. Rev. Letters, 16: 359(1963)) observed a more complicated dependence of the current on the voltage. The authors of [1,2] relate the appearance of peaks with tunneling of certain particles. Such processes, however, have low probability and lead to a very rapid decrease of the intensity of increasing peak number, in disagreement with the data of [1,2]. In [3] the complicated dependence of the current on the voltage was attributed to the anisotropy of the electric gap. Another mechanism is proposed which is apparently in good agreement with both the results of [1,2] and the data of [3]. (W.D.M.)

9483 COULOMB INTERACTION IN A SUPERCONDUCTOR MODEL OF TWO ZONES. Moskalenko, V. A.; Palistrant, M. E. (Inst. of Mathematics with Computing Center, Academy of Sciences, MSSR). Dokl. Akad. Nauk SSSR, 169: 812-15(1966). (In Russian).

The effects of Coulomb interactions between electrons on the magnitude of critical temperature was studied using a two-zone model for pure superconductors with a non-magnetic admixture and considering Bardin-Pains hamiltonian for two-zone model, with Bloch functions $\Psi_{nk}(x)$ as the basic second quantization function. (R.V.J.)

9484 THEORY OF SUPERCONDUCTING CONTACTS. Fulde, Peter; Maki, Kazumi (Univ., Frankfurt am Main). Phys. Kondens. Mater., 5: 380-91(1966).

Metallic contacts between superconducting and normal films are known to have a pair-breaking effect on the electron pairs. By limiting considerations to the gapless regime and to contacts between superconducting and paramagnetic metals the features of this pair-breaking mechanism are investigated. The normalization of the order parameter and with it such quantities as the tunneling conductance, electrical and thermal conductivity and the critical current parallel to the contact were computed. The influence of a magnetic field was investigated. By calculating the $\kappa_2(t)$-parameter the interplay between the different pair-breaking mechanisms in perpendicular and parallel fields was demonstrated. In the latter case the influence of the contact on the superconducting sheath proposed by Saint-James and de Gennes is discussed. Experiments to test the present theory are suggested. (auth)

9485 ON THE POLARIZATION OPERATOR OF THE SUPERCONDUCTOR WITH THE P-PAIRING. Czerwonko, J. (Univ., Wroclaw). Bull. Acad. Pol. Sci., Ser. Sci. Math. Astron. Phys., 14: 463-71(1966).

The theory of collective excitations for superconductors with p-pairing has been recently developed. The polarization operation is defined as the operator which gives the average four-current acting on the electromagnetic four-potential. Only the influence of the static magnetic field was studied. (W.D.M.)

9486 WAVE PROPAGATION IN THE JOSEPHSON TUNNEL JUNCTION IN THE PRESENCE OF VORTICES AND THE ELECTRODYNAMICS OF WEAK SUPERCONDUCTIVITY. Kulik, I. O. (Inst. of Physics and Tech., Academy of Sciences, Ukrainian SSR). Zh. Eksp. Teor. Fiz., 51: 1952-69(Dec. 1966). (In Russian).

Some features of the dynamic mixed state of weak superconductivity (Josephson effect) in external fields $H \perp E$ are investigated. Such a state which is characterized by the presence of a moving vortex chain arises when the electric and magnetic field strengths exceed some certain critical values. The equation of the critical state is deduced. The magnetization curve for a Josephson superconductor, $M(H_0)$, is plotted which is similar to the corresponding curve in the Abrikosov theory of superconductors of the second kind. Propagation of waves in the presence of vortices is considered. Vortex motion in the mixed state is accompanied by the appearance of radiation with frequencies $\omega_n = 2en\overline{V}/\hbar$, where $\overline{V}$ is the mean barrier voltage. The model, which yields an exact solution, can also be employed for qualitative analysis of resistive effects in superconductors of the second kind. (auth)

9487 CRYOSTAT OPERATING ON THE HEAT OF TRANSITION OF ^{3}He FROM AN ^{3}He-RICH SOLUTION TO AN ^{4}He-RICH SOLUTION. Peshkov, V. P. (Inst. of Physical Problems, Academy of Sciences, USSR). Zh. Eksp. Teor. Fiz., 51: 1821-8 (Dec. 1966). (In Russian).

Calculations referring to an installation operating on the heat of transfer of ^{3}He from one liquid phase of helium to another are presented. It is shown that at temperatures of the order of millidegrees the cold productivity is proportional to the heat of transition $q = 100\ T^2$. When the ^{3}He circulation rate is 1.6×10^{-4} M/sec a temperature of 0.001°K can be attained and 5 ergs/min can be absorbed at this temperature. (auth)

9488 VELOCITY OF FIRST SOUND IN ^{3}He–^{4}He SOLUTIONS. Eselson, B. N.; Dyumin, N. E.; Rudavskii, E. Ya.; Serbin, I. A. (Inst. of Physics and Tech., Academy of Sciences, Ukrainian SSR). Zh. Eksp. Teor. Fiz., 51: 1665-8(Dec. 1966). (In Russian).

The velocity of first sound in helium isotope solutions containing up to 20% of ^{3}He is measured at temperatures between 1.6 and 4.0°K. A linear dependence of the sound velocity on concentration is found to hold at a constant temperature. (auth)

9489 HEAT FLOW IN A SUPERCONDUCTOR IN THE VORTEX STATE. Parks, R. D.; Zumsteg, F. C.; Mochel, J. M. (Univ. of Rochester, N. Y.). Phys. Rev. Lett., 18: 47-9(Jan. 9, 1967).

Measurements of the thermal conductivity of a superconductor in the vortex state in a regime where the electrons are the dominant heat carriers are reported. The following new results were found: (1) the thermal conductivity is strictly proportional to $H - H_{c1}$ in the entire field range $H_{c1} \lesssim H \lesssim H_{c2}$, and (2) there is a pronounced anisotropy of the thermal conductivity with respect to whether the direction of heat flow is parallel or perpendicular to the axes of the vortices. In addition it was observed that thermal conductivity measurements provide a method for determining very accurately the lower and upper critical fields (H_{c1} and H_{c2}) of a type-II superconductor. (W.D.M.)

9490 ULTRASONIC ATTENUATION IN A PURE TYPE-II SUPERCONDUCTOR NEAR H_{c2}. Kagiwada, Reynold (Univ. of California, Los Angeles); Levy, Moises; Rudnick, Isadore; Kagiwada, Harriet; Maki, Kazumi. Phys. Rev. Lett., 18: 74-6(Jan. 16, 1967).

A new theory of ultrasonic attenuation in the mixed state of a pure type-II superconductor in a high magnetic field was recently proposed. Experimental results on longitudinal and transverse wave propagation in two pure single crystals of niobium are presented; the results are then compared with theoretical predictions. (W.D.M.)

9491 STUDY OF A NEW MAGNETIC REFRIGERATING CYCLE. van Geuns, J. R. (Univ. of Leiden). Philips Res. Rep. (Suppl.), No. 6, 1-105(1966).

The possibility of using magneto-caloric effects for a refrigerating machine in which cold can be generated at a temperature of about 4°K was investigated. These effects are obtained with paramagnetic materials. The adiabatic demagnetization of such materials has long served as a method for attaining temperatures well below 1°K. A new cycle, however, is needed for application at higher temperatures. It should preferably be suitable for a fast-running refrigerator. The cycle evolved for this purpose resembles in many respects the Stirling cycle in gas-refrigerating machines and hot-gas engines. In the new cycle, helium is used to transfer heat from the paramagnetic material to a heat exchanger and vice versa. The helium is also used, moreover, as a regenerator. In order to prevent phase transitions, the helium pressure chosen is above the critical pressure. The value of the new refrigerator as a replacement for the familiar Joule–Thomson process is discussed. A theoretical analysis of the refrigerator based on the new cycle is given. After a detailed exposition of the principle underlying this cycle, a simplified model for the fairly complicated processes taking place in the new refrigerator is introduced. A calculation scheme is worked out with the aid of this model. In the analysis a great deal of attention is devoted to the regenerator. The behavior of this regenerator deviates from that of normal regenerators, in that work can be carried out on the paramagnetic material during its passage through the regenerator. The design of a magnetic refrigerator working between 15 and 4°K is given. The calculated performance of this machine compared with a Carnot cycle is found to be very high (60 to 70%). The properties of the new refrigerating machine are compared with those of one working on the Joule–Thomson principle. The measurements carried out in order to obtain paramagnetic materials suitable for the new refrigerator are discussed. Such an investigation was necessary, as the materials normally used for adiabatic demagnetization are unsuitable for the purpose. The materials investigated were a number of mixed oxides of rare-earth and other metals. The magnetic susceptibility and the entropy of these materials were measured, a number of them being found to be eminently suitable for the new magnetic refrigerator. (auth)

9492 THEORY OF FIRST SOUND IN DILUTE SOLUTIONS OF ^{3}He IN ^{4}He AT VERY LOW TEMPERATURES. Baym, Gordon (Univ. of Illinois, Urbana). Phys. Rev. Lett., 18: 71-4 (Jan. 16, 1967).

The velocity and attenuation of first sound in dilute solutions of ^{3}He in very low-temperature ^{4}He are calculated. The theoretical attenuation agrees well with that measured recently by Abraham, Eckstein, Ketterson, and Vignos. (auth)

9493 USE OF POINT CONTACTS TO OBTAIN DIRECT EVIDENCE OF FLUX MOTION IN SUPERCONDUCTORS. Chandrasekhar, B. S.; Farrell, D. E.; Huang, S. (Western Reserve Univ., Cleveland). Phys. Rev. Lett., 18: 43-5(Jan. 9, 1967).

Sharvin (JETP Letters 2: 183(1965)) observed oscillations of the resistance of a small area of superconducting tin disk and inferred that normal domains were in continuous motion across the sample. An experimental study of this effect was made and it was found that oscillations such as Sharvin observed can occur very generally when current is passed via a point contact into a superconductor. The phenomena are complex and the application of a magnetic field further complicates the spectrum of oscillations obtainable, but is not a necessary condition for their appearance. From this fact and others, it is concluded that oscillations can arise from an instability of the normal–superconducting interface in the region of the contact and so do not necessarily involve domain motion as envisaged by Sharvin. (W.D.M.)

9494 INTERACTION OF FERROMAGNETIC AND SUPERCONDUCTING THIN FILMS. Artley, J. L.; Buckley, G.; Willis, C. A. Jr.; Chambers, W. F. (Duke Univ., Durham, N. C.). Appl. Phys. Lett., 9: 429-32(Dec. 15, 1966).

Experimental evidence is presented to show that the domain walls in a thin film of permalloy may be used to influence the transition of a thin indium film as it goes from the superconducting to normal state. The magnetic field of the domain walls in the permalloy film drives the superconducting indium toward a normal state and the superconducting indium film tends to lock the domain walls of the permalloy into a permanent position. (auth)

9495 ON THE DERIVATION OF GENERALIZED GINZBURG–LANDAU EQUATIONS. Menyhard, Nora (Central Research Inst. for Physics, Budapest). Acta Phys. Acad. Sci. Hung., 21: 277-92(1966).

The consequences of using more realistic effective electron–electron interactions than the BCS one in the derivation of the Ginzburg–Landau equations and their generalizations are examined. Gorkov's equations for the thermodynamic Green's functions are used as a starting point. The gap parameter is given in terms of a general nonlocal two-particle interaction and the anisotropy of the one particle spectrum is also taken into account. Generalized Werthamer's equations are obtained and shown to reduce to modified Ginzburg's equations for $T \lesssim T_c$. Within the same limit neglecting anisotropy effects the Ginzburg–Landau equations result. (auth)

9496 PHYSICAL LIMITATIONS ON THE SIZE OF SUPERCONDUCTING POWER TRANSFORMERS. Borcherds, P. H. (Univ. of Birmingham, Eng.). Proc. Inst. Elec. Eng. (London), 113: 1953-6(Dec. 1966).

The volume of a superconducting transformer is calculated by investigating the behavior of an idealized, lossfree, interleaved transformer. Because of the limitation of leakage magnetic fields with superconducting windings, it is found that the volume is large compared with a conventional transformer of the same power rating. It is shown how the volume of an idealized transformer can be reduced. When account is taken of the additional factors involved in designing a real superconducting transformer, it seems very probable that its size will be so much larger than that of an equivalent conventional transformer as to be unacceptable. (auth)

9497 IMPULSE AND VORTICES. Huggins, Elisha R. (Dartmouth Coll., Hanover, N. H.). Phys. Rev. Lett., 17: 1284-6(Dec. 26, 1966).

The impulse required to create a vortex ring in a cylindrical tube is calculated. The effects of solid boundaries on the calculation procedure are considered. Existing predictions for the critical velocity required to create vortex rings in liquid helium are discussed in relation to the calculation procedure. (A.G.W.)

9498 POSSIBLE ORGANIC SUPERCONDUCTORS. Salem, Lionel (Faculte des Sciences, Orsay, France). Mol. Phys., 11: 499-502(1966).

A previous proposal by Little indicates that certain organic molecules, built out of a conjugated polyenic spine together with a series of regularly spaced side chains, may possibly be superconducting. A discussion is given on the possibility of building a side-chain molecule where the transition density is effectively localized at the ends of the molecule, thereby providing for a very large interaction between the positive charge induced at one end and the polyene electrons. (J.H.M.)

9499 LOCALIZATION OF SPINS IN A SUPERCONDUCTOR. Akhtyamov, O. S.; Fedorov, E. I. JETP Lett. (USSR) (Engl. Transl.), 4: 280-1(Nov. 15, 1966).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Redaktsiyu, 4: 416-18(Nov. 15, 1966).

A brief theoretical study was made of the effects of superconductivity on spin localization. The analysis is outlined. (M.O.W.)

9500 PROPAGATION OF SHEAR AND COMPRESSIONAL SOUND IN SOLID HELIUM. Lipschultz, Frederick Phillip. Ithaca, N. Y., Cornell Univ., 1966. 156p.

Thesis.

The velocity of propagation of both shear and compressional waves in solid ^{4}He and solid ^{3}He were measured at 10 megacycles per second. The acoustic studies were performed in the bcc and hcp allotropes of ^{4}He for pressures less than 30 atm and near the melting curve, and in the bcc allotrope of ^{3}He for pressures below 45 atm. These studies represent the first measurement of shear velocities in solid helium. Compressional velocity data in previously unstudied portions of the phase diagrams were also obtained; compressional velocities in other regions of the phase diagram agreed with earlier measurements by other investigators. (TSS)

9501 SPIN-LATTICE RELAXATION OF LIQUID ^{3}He AND OF ^{3}He–^{4}He MIXTURES. Horvitz, Ephrem Philip. Houston, Tex., Rice Univ., 1966. 77p.

Thesis.

The relaxation times T_1 and T_2 of ^{3}He nuclei in pure liquid ^{3}He and in liquid ^{3}He–^{4}He mixtures were measured in the temperature range $0.9°K < T < 2.6°K$. Reproducible relaxation times longer than those previously reported were obtained by employing an extensive cleaning procedure. The Pyrex sample chamber and filling capillary were repeatedly cleaned in the presence of several mm. of pure ^{4}He by heating the glass to almost melting and, at the same time, touching the glass surface with a Tesla coil. This coil creates a high frequency discharge which drives adsorbed gases off the wall. T_1 for pure ^{3}He was found to have the value and the temperature dependence predicted by the modified BPP theory to within ±3%. T_1 is proportional to the diffusion coefficient, and increases from 350 seconds at 1.0°K to 450 seconds at 1.8°K. T_2 was found to be approximately equal to T_1. These long relaxation times were significantly shortened by contamination of the clean chamber with air or by inadequate purification of the ^{3}He sample. Since the work on pure ^{3}He showed that wall effects could be minimized by cleaning, it was considered of interest to measure T_1 in ^{3}He–^{4}He mixtures. The relaxation times of a 33% ^{3}He solution were determined in an extensively cleaned system. Above the lambda point, T_1 is about 50% greater than for pure ^{3}He, while just below this temperature it increases sharply by about 15%. Measurements of T_1 of other mixtures were made in partially cleaned systems. The results were affected by wall relaxation and bulk impurities. Some conclusions about T_1 are drawn from these data. Other experiments are discussed in which results are affected by paramagnetic impurities. It is suggested that the cleaning procedure described may be helpful in clarifying these results. In order to achieve a better understanding of the experimental results where impurities are important, a study of nuclear spin-lattice relaxation in non-conducting solids was undertaken. Bloembergen has shown that direct relaxation of the nuclei by paramagnetic impurities together with nuclear spin diffusion gives the sample a unique relaxation time. This work was extended by deriving the correlation functions of the z, x–iy, and x + iy components of the impurity spin. This gives a new formula for direct relaxation. It is also shown that the paramagnetic impurity can induce spin diffusion in the nuclear spin system. (Dissertation Abstr.)

9502 MAGNETIC FIELD OF A ROTATING SUPERCONDUCTOR. Hendricks, John Benjamin. Houston, Tex., Rice Univ., 1966. 63p.

Thesis.

For a rotating superconductor the London equations must be modified: $c\ \mathrm{curl}\ (\Lambda\ \underline{j}) = -(\underline{B} + \underline{B}')$, $\underline{B}' = 2mc/e\ \underline{\omega}$, $\partial/\partial t\ (\Lambda\ \underline{j}) = \underline{E} + \underline{E}'$, $\underline{E}' = -\ m/c\ \partial/\partial t\ (\underline{\omega} \times \underline{r})$. These, together with Maxwell's equations describe the macroscopic electrodynamic properties of the rotating superconductor. The following predictions are consequences of these equations: For a solid superconductor, the fluxoid threading the sample is $\varphi = \int_S \int [\underline{B} + (2mc/e)\ \underline{\omega}] \cdot \underline{ds} = 0$. This means that a uniform magnetic field $\underline{B} = -\ 2mc/e\ \underline{\omega}$ will appear reversibly in a rotating solid superconductor. For a hollow cylinder with walls thicker than the penetration depth, the fluxoid in the hole is $\varphi = \int_S \int [\underline{B} + (2mc/e)\ \underline{\omega}] \cdot dS = \text{constant}$. In order to find the actual behavior of the rotating superconductor,

a high speed spinner system has been constructed and experiments on both solid and hollow tin cylinders have been performed. The system included a magnetic shield and Helmholtz coil system so the external magnetic field could be reduced to less than 1×10^{-4} gauss. The principal results of these experiments are: An independent measurement of the London field has been made. The average value for four runs was $\underline{B}/\underline{\omega} = 1.17 \times 10^{-7}$ gauss-seconds, which compares to the theoretical value of $\underline{B}/\underline{\omega} = 1.137 \times 10^{-7}$ gauss-seconds. The accuracy of the measurement was ±5%. The London field appears reversibly only in solid cylinders which are single crystals of high-purity material. The hollow cylinders behave as predicted. That is, if the superconducting transition takes place with $\underline{B}_{external} = 0$ and $\underline{\omega} = \underline{\omega}_0$ and then the rotation is stopped, the field inside the cylinder will be $\underline{B} = 2mc/e\ \underline{\omega}_0$. Solid cylinders in which the London field does not appear reversibly behave like hollow cylinders. That is, the external and rotation fields are trapped in the solid. (Dissertation Abstr.)

9503 MECHANICAL STUDY OF THE FORCES ON MOVING INTERMEDIATE-STATE REGIONS IN A TYPE I SUPERCONDUCTOR. McAshan, Michael Sanford. Houston, Tex., Rice Univ., 1966. 72p.

Thesis.

Experiments are described which were performed on a system consisting of a superconducting tin disc suspended to oscillate about its axis in a torsion pendulum. This is acted upon by a pair of stationary coils which apply two local regions of magnetic field at points diametrically opposite on the disc and directed normal to its surface. As the system oscillates, the intermediate-state regions produced by the coils are moved through the superconductor, and the resulting forces are determined from the motion. The results can be understood phenomenologically in terms of the same ideas that have been applied to flux motion in type II superconductors. For small velocities, there is an exponential dependence of the velocity of the flux motion upon the applied force, indicating that flux creep is occurring. For larger forces and velocities, the dependence is linear, showing flux flow. Because of a dependence of the behavior of the system on history, however, no very firm conclusions have been reached concerning the dependence of the parameters of the phenomenological theory on the properties of the superconductor or on the magnetic field. The exception to this is in the measurements of the flow viscosity. These show a reasonably well-defined, although unexplained, field dependence and a probable dependence on the first power of the normal-state conductivity. (Dissertation Abstr.)

9504 MAGNETIZATION MEASUREMENTS IN SUPERCONDUCTIVE MOLYBDENUM. Mallon, Richard Glenn. Houston, Tex., Rice Univ., 1966. 59p.

Thesis.

The magnetization curves of three samples of superconductive molybdenum have been measured in a helium-3 cryostat for $0.40 < T < T_c$. The samples were single crystals obtained from two different sources. All three were prepared by electron-beam float-zone refining. Transition temperatures of the samples were 0.899°K, 0.903°K, and 0.906°K. The magnetization curves show that molybdenum is a type I superconductor. Both supercooling and flux trapping were observed in the normal-to-superconductive transition. Most of the flux remaining in the sample following the transition disappeared linearly with the field as the applied field was lowered. The critical field has been measured as a function of temperature and the result compared with BCS theory. (auth)

9505 METALLOVEDENIE I METALLOFIZIKA SVERKHPROVODNIKOV, TRUDY I SOVESHCHANIYA PO METALLOVEDENIYU I METALLOFIZIE SVERKHPROVODNIKOV, 25–27 MAYA 1964, MOSCOW. (Metallography and Metal Physics of Superconductors, Reports of the First Conference on Metallography and Metal Physics of Superconductors, May 25–27, 1964, Moscow). Savitskii, E. M.; Baron, V. V. (eds.). Moscow, Izdatel'stvo Nauka, 1965. 167p. (CONF-640531–).

Separate abstracts have been prepared for twenty-one papers. A review article on work done outside Russia was not abstracted. (M.H.R.)

For abstracts of individual papers see: 9092, 9479–9481, and 9506–9522.

9506 STATUS AND PROBLEMS OF SCIENTIFIC RESEARCH WORK OF SUPERCONDUCTING MATERIALS. Savitskii, E. M. pp 3-16 of Metallovedenie i Metallofizika Sverkhprovodnikov. Savitskii, E. M.; Baron, V. V. (eds.). Moscow, Izdatel'stvo Nauka, 1965. (In Russian).

Problems involved in research in superconductivity are reviewed. Among these are the metallurgical factors, economics, interrelationship of structure and properties in the search for new superconductors, research on superconducting systems, and the design of superconducting solenoids and cryostats and their testing by new equipment devices. (M.H.R.)

9507 THEORY OF SUPERCONDUCTORS WITH HIGH CRITICAL FIELDS AND CURRENT. Shmidt, V. V. pp 17-28 of Metallovedenie i Metallofizika Sverkhprovodnikov. Savitskii, E. M.; Baron, V. V. (eds.). Moscow, Izdatel'stvo Nauka, 1965. (In Russian).

A brief review is given on superconductivity in large magnetic fields at high current densities. Magnetic properties of uniform and nonuniform or hard superconductors were examined. The hard superconductors exhibited the ability of withstanding high critical currents with the critical current magnitude depending on the concentration of the nonuniformities. The curve of hard superconductor critical current density was constructed as a function of the external magnetic field at various plastic deformations. The Anderson theory is discussed. (R.V.J.)

9508 SUPERCONDUCTING NIOBIUM–ZIRCONIUM ALLOYS AND THE EFFECT OF HEAT TREATMENT ON THEIR PROPERTIES. Baron, V. V. pp 29-38 of Metallovedenie i Metallofizika Sverkhprovodnikov. Savitskii, E. M.; Baron, V. V. (eds.). Moscow, Izdatel'stvo Nauka, 1965. (In Russian).

The relationship between the critical current (I_{cr}) in an external magnetic field at 4.2°K and the structure of superconducting Nb–Zr alloys after cold deformation and various thermal treatment was investigated. Arc-melted Nb–Zr alloys containing up to 65 at. % Zr were cold rolled and cold drawn into a wire 0.20 to 0.25 mm in dia with a total reduction of 99.75%, and annealed at temperatures up to 1050°C for various periods of time. All cold-deformed alloys had a bcc lattice of β solid solution with a lattice constant which increased linearly from 3.31 to 3.5 Å with increasing zirconium content from 0 to 65 at. % Zr. The critical current of cold-deformed alloys increased with increasing Zr content. In an external magnetic field of 22 kOe, the I_{cr} density reached a maximum of 6 to 8×10^4 amp/cm^2 in alloys containing 20 to 25% Zr, and then dropped to 4 and 2×10^4 amp/cm^2 at Zr contents of 30 and 50%, respectively. The I_{cr} density also increased with an increase in reduction to 99.9%, e.g., to 1.6 to 2×10^5 amp/cm^2 in an alloy with 25% Zr. Cold-deformed alloys with 25, 30, and 50% Zr had a transition temperature of 11.2, 11, and 10.5°K, respectively—the alloys with the highest I_{cr} had a higher transition temperature. Annealing at temperatures up to 600°C had little or no effect on structure, strength and I_{cr}. A sharp increase in I_{cr} takes place with annealing at 600 to 800°C, which brings about a decomposition of the solid solution. With a further increase of annealing temperature, I_{cr} gradually decreased as the alloy approached the equilibrium state. The sharp increase in I_{cr} after annealing at 600 to 800°C is probably associated with distortions in the crystal lattice of β solid solution and with the formation of a great number of physical and chemical inhomogeneities. This assumption is well confirmed by a minimum strength and ductility observed at the maximum of I_{cr}. (ATD)

9509 EFFECT OF ALLOYING ADDITIONS ON THE SUPERCONDUCTIVITY OF NIOBIUM–ZIRCONIUM ALLOYS. Myzenkova, L. F.; Efimov, Yu. V.; Baron, V. V.; Savitskii, E. M. pp 39-43 of Metallovedenie i Metallofizika Sverkhprovodnikov. Savitskii, E. M.; Baron, V. V. (eds.). Moscow, Izdatel'stvo Nauka, 1965. (In Russian).

The effect of small additions of cerium, lanthanum, titanium, and iron on the critical current density (I_k) of niobium–zirconium alloys was investigated. Alloy wires 0.25 mm in dia, containing 25 and 50 wt % Zr and up to 0.36% La, 0.39% Ce, 5.44% Ti, or 0.5% Fe individually added, were tested at 4.2 K in a magnetic field of 22.4 kG. Ti, Fe, La, and Ce at contents of up to 0.1% increased considerably the I_k of Nb + 50% Zr alloy. At higher contents, I_k dropped again. In the case of Nb + 25% Zr alloy, the maximum on the I_k-composition curves was observed at higher contents of alloying elements, for instance, at 1% titanium, but the effect was much weaker than in alloy with 50% Zr. The effect of higher content of alloying elements was studied with alloys containing 5 and 10% Ti and 20 to 45% Zr. At 5% Ti the maximum I_k, $4.45 \cdot 10^4$ a/cm^2, was observed at 28% Zr and in alloys with 10% Ti, at 25% Zr (I_k, $3.65 \cdot 10^4$ a/cm^2). Titanium, La, and Ce improved and Fe did not affect the workability of alloys. Annealing at 900 C for 1 hr had a beneficial effect on the I_k of alloys with 25 and 50% Zr containing La and Ce. (ATD)

9510 INFLUENCE OF STRUCTURAL STATE ON SUPERCONDUCTING PROPERTIES OF ALLOYS OF ZIRCONIUM WITH 20 TO 25 PERCENT NIOBIUM. Bychkov, Yu. F.; Goncharov, I. N.; Khukhareva, I. S. pp 44-52 of Metallovedenie i Metallofizika Sverkhprovodnikov. Savitskii, E. M.; Baron, V. V. (eds.). Moscow, Izdatel'stvo Nauka, 1965. (In Russian).

Ingots were smelted in an arc furnace with unconsumable electrodes in an atmosphere of argon, and in an electron-beam furnace.

Zirconium iodides and niobium refined in an electron-beam furnace were used as initial materials. Out of the ingots, tape and wire were prepared which were subjected to intermediate temper with subsequent deformation or final temper. All properties except durability were measured in alloys prepared in a laboratory arc furnace. Measurement of the critical current density, critical transition temperature, and relative electrical resistance were conducted on tapes of 0.05 mm thickness. Wires of 0.25 mm dia were used for determination of critical current density, critical transition temperature, relative electrical resistance, internal friction, and shear modulus. Durability properties were measured on tapes of 1 mm thickness. Shear modulus and internal friction were measured with wire models on a torsion pendulum. (M.H.R.)

9511 SUPERCONDUCTING PROPERTIES OF NIOBIUM–TITANIUM ALLOYS AND INFLUENCE OF ALLOYING ADDITIONS ON CRITICAL DENSITY OF CURRENT. Baron, V. V.; Bychkova, M. I.; Savitskii, E. M. pp 53-8 of Metallovedenie i Metallofizika Sverkhprovodnikov. Savitskii, E. M.; Baron, V. V. (eds.). Moscow, Izdatel'stvo Nauka, 1965. (In Russian).

The changes in critical current density of niobium with titanium alloys of different compositions (5.5, 14.8, 32.6, 48.8, 55.61, and 68 wt % Ti) were investigated, depending upon the value of the external magnetic field, and the influence of small additions (0.2 to 0.5%) of certain elements on the characteristics and mechanical properties of the alloys. (M.H.R.)

9512 SUPERCONDUCTING PROPERTIES OF VANADIUM–TITANIUM ALLOYS. Efimov, Yu. V.; Baron, V. V.; Savitskii, E. M. pp 59-64 of Metallovedenie i Metallofizika Sverkhprovodnikov. Savitskii, E. M.; Baron, V. V. (eds.). Moscow, Izdatel'stvo Nauka, 1965. (In Russian).

The critical current densities of vanadium–titanium alloys with bcc lattice were investigated, depending upon the intensity of the external magnetic field (to 22.2 kG) and the concentration of titanium in alloys (to 74 wt %). Mechanical properties and microstructure of alloys and the influence of thermomechanical treatment on the superconducting properties of alloys were also studied. (M.H.R.)

9513 SUPERCONDUCTIVITY OF REFRACTORY COMPOUNDS. Samsonov, G. V. pp 65-71 of Metallovedenie i Metallofizika Sverkhprovodnikov. Savitskii, E. M.; Baron, V. V. (eds.). Moscow, Izdatel'stvo Nauka, 1965. (In Russian).

Previous work on the superconductivity of refractory compounds is reviewed in order to permit systematization of experimental data and to reveal certain regularities of appearance of superconducting properties in such compounds. This is done to make it possible to outline the more probable areas in which to search for new refractory superconductors. (M.H.R.)

9514 PHASE DIAGRAM OF THE NIOBIUM–TIN SYSTEM. Kogan, V. S.; Krivko, A. I.; Lazarev, B. G.; Lazareva, L. S.; Matsakova, A. A.; Ovcharenko, O. N. pp 76-82 of Metallovedenie i Metallofizika Sverkhprovodnikov. Savitskii, E. M.; Baron, V. V. (eds.). Moscow, Izdatel'stvo Nauka, 1965. (In Russian).

Earlier work in which it was found that specimens produced by holding niobium in molten tin at temperatures above and below 850°C differed in their superconducting properties is continued. The superconductivity transition temperature for specimens produced at 990 and 1250°C is 18.0 and 18.1°K, respectively. For diffusion layers formed at below 850°C, the superconductivity transition temperature is reduced; the lower T_k, the lower the temperature of formation of the layer. For specimens obtained at above 850°C, T_k agrees with the known value for Nb_3Sn. X-ray studies confirmed that only the compound Nb_3Sn is formed when specimens are prepared at over 850°C. For temperatures below 850°C, the diffraction pattern shows that Nb_2Sn_3 is formed. It was concluded that in specimens prepared at temperatures below 850°C there is present a very thin interlayer beneath the new phase. The formula NbSn is ascribed to the new compound. The superconductivity transition temperature of the NbSn was found to be 2.7°K. In other papers the new compound has been given the formula $NbSn_2$ or Nb_2Sn_3. (ATD)

9515 INVESTIGATION OF THE CRITICAL CURRENT DENSITY IN THE Nb–Sn SOLID SOLUTION. Telentyuk, G. E.; Baron, V. V.; Savitskii, E. M. pp 83-5 of Metallovedenie i Metallofizika Sverkhprovodnikov. Savitskii, E. M.; Baron, V. V. (eds.). Moscow, Izdatel'stvo Nauka, 1965. (In Russian).

The superconducting critical current densities and transition temperatures of various wt % alloys of Nb and Sn were studied as a function of magnetic field strength at 4.2°K. It was found that as the percent of Sn increased the critical current and transition temperature decreased. (R.V.J.)

9516 CONSTITUTION DIAGRAM OF NIOBIUM–GALLIUM SYSTEM. Baron, V. V.; Myzenkova, L. F.; Savitskii, E. M. pp 86-8 of Metallovedenie i Metallofizika Sverkhprovodnikov. Savitskii, E. M.; Baron, V. V. (eds.). Moscow, Izdatel'stvo Nauka, 1965. (In Russian).

Constitution diagram of Nb–Ga alloy showed a limited solid solution with Nb base in which Ga diffusion into Nb at 800°C was about 8 to 10 wt % Ga. At higher temperature Ga diffusion into Nb increased and at the peritectic reaction temperature it reached 16 wt %. It was also shown that in addition to the known compound Nb_3Ga (20 wt % Ga) there are three other compounds: Nb_5Ga_3 (31.08 wt % Ga) ~Nb_2Ga_3 (~51 wt % Ga), and $NbGa_3$ (69.29 wt % Ga) formed by peritectic reactions at 1720, 1530, 1350, and 1235°C, respectively. Data on the microhardness, microstructure, and thermal analysis indicate the possibility of a compound with 50 to 53 wt % Ga (Nb_2Ga_3). Niobium reduced the melting point of Ga. In the liquid state Nb and Ga are completely diffused into each other. (R.V.J.)

9517 SUPERCONDUCTIVITY OF V_3Ga. Lazarev, B. G.; Lazareva, L. S.; Matsakova, A. A.; Ovcharenko, O. N. pp 89-90 of Metallovedenie i Metallofizika Sverkhprovodnikov. Savitskii, E. M.; Baron, V. V. (eds.). Moscow, Izdatel'stvo Nauka, 1965. (In Russian).

Compression effects on the transition temperature T_c and the critical magnetic field dependence H_c on the temperature were measured in order to determine properties of superconducting V_3Ga. Superconducting transition curves for a V_3Ga specimen measured without pressure (T_c = 14.06°K) and under pressure (1730 kg/cm^2) showed that the pressure reduced the transition temperature by 0.03°, or the $dT_c/dP = -1.7 \times 10^{-5}$ grad/atom. The measurements of critical field dependence H_c on the temperature near T_c showed the magnitude $dH_c/dT = -44{,}000$ Oe/grad, which is in good agreement with published data. (R.V.J.)

9518 ALLOYING EFFECTS ON THE CRITICAL TEMPERATURE OF V_3Si TRANSITION INTO SUPERCONDUCTING STATE AND THE PERIOD OF THE CRYSTALLINE LATTICE. Efimov, Yu. V.; Baron, V. V.; Savitskii, E. M.; Gladyshevskii, E. I. pp 91-100 of Metallovedenie i Metallofizika Sverkhprovodnikov. Savitskii, E. M.; Baron, V. V. (eds.). Moscow, Izdatel'stvo Nauka, 1965. (In Russian).

Microstructure, microhardness, and x-ray analyses were made of the diffusion of 17 elements (O, C, B, Ce, La, Ti, Zr, Nb, Cr, Mo, Mn, Re, Pd, Ge, Sn, Al, and Be) in V_3Si and the effect of the diffusion on the critical temperature of transition into the superconducting state. Tabulated data showed that small amounts of carbon, boron, oxygen, and nitrogen impurities reduce the transition temperature. In spite of the observed changes in the lattice period and electron concentrations in V_3Si compounds alloyed with transition metals, the T_c is reduced. The critical temperature of V_3Si–Mo_3Si alloy transition was sharply reduced in alloys with small Mo contents (up to 5 at. %). With 25 at. % Mo the alloys lost their superconductivity at ≥1.90°K. (R.V.J.)

9519 SOLENOID PREPARED FROM NIOBIUM–TITANIUM ALLOY. Kurganov, G. B.; Karasik, V. R.; Baranov, I. A.; Shmulevich, R. S. pp 115-17 of Metallovedenie i Metallofizika Sverkhprovodnikov. Savitskii, E. M.; Baron, V. V. (eds.). Moscow, Izdatel'stvo Nauka, 1965. (In Russian).

Properties of short wire specimens and solenoids prepared from Nb–Ti (50 wt % Ti) alloys were studied for diameters of 0.2 mm and lengths of 890 mm. Curves of critical currents of the external field measured in a short wire specimen and in two solenoids were analyzed. Results confirmed published data on tests made with solenoids with internal-section windings made with Nb–Ti and external windings with Nb–Zr and fields of 90 to 100 kG. (R.V.J.)

9520 DEVICE FOR INVESTIGATING THE CRITICAL CURRENT IN SUPERCONDUCTORS AND ITS APPLICATION FOR STUDYING THE EFFECT OF IRON IMPURITY ON THE SUPERCONDUCTING PROPERTIES OF NIOBIUM–ZIRCONIUM ALLOY. Kurganov, G. B.; Karasik, V. R.; Sviridonov, M. N.; Baranov, I. A.; Shmulevich, R. S.; Novokreshchenova, V. B.; Sentyurina, N. N. pp 118-19 of Metallovedenie i Metallofizika Sverkhprovodnikov. Savitskii, E. M.; Baron, V. V. (eds.). Moscow, Izdatel'stvo Nauka, 1965. (In Russian).

A device is described for measuring the critical current of short wire samples as a function of the external transverse magnetic field (range 0 to 40 kOe). The magnetic field is created by a solenoid with windings of niobium–zirconium wire, whose construction was described in a preceding article. The device was used for investigating the properties of 0.2-mm-diameter wire of Nb–26% Zr alloy alloyed with iron (0.5, 0.4, 0.2, and 0.008% Fe). In general, an increase in Fe content decreased the magnitudes of both critical current and the critical field. (ATD)

9521 DEVICE FOR MEASURING THE CRITICAL TEMPERATURE OF SUPERCONDUCTORS. Akhmedov, S. Sh.; Vylegzha-

nina, T. N. pp 120-2 of Metallovedenie i Metallofizika Sverkhprovodnikov. Savitskii, E. M.; Baron, V. V. (eds.). Moscow, Izdatel'stvo Nauka, 1965. (In Russian).

Two devices for measuring the critical temperature of superconductors are described. The first is based on the diamagnetic effect. A superconducting solenoid creating an alternating magnetic field is placed around a small Dewar flask inside of which are mounted identical coils. When the specimen is in the normal state, the emf induced in each coil compensates the other. When the specimen goes into the superconducting state, the magnetic field is excluded from the coil containing the specimen, and the compensation is destroyed. The temperature is controlled by means of a heater wrapped around a thin-walled German silver tube containing liquid helium, which is thermally coupled to the specimen by a copper base. The second device, while similar in most respects to the first, detects the appearance of electrical resistance in the specimen when it makes the transition from the superconducting to the normal state. Both devices are capable of measuring the critical temperature to an accuracy of 0.01°K. (ATD)

9522 APPLICATION OF MOESSBAUER EFFECT IN THE INVESTIGATION OF SUPERCONDUCTING ALLOYS. Zhdanov, G. S.; Ibraimov, N. S.; Kuzmin, R. N. pp 123-9 of Metallovedenie i Metallofizika Sverkhprovodnikov. Savitskii, E. M.; Baron, V. V. (eds.). Moscow, Izdatel'stvo Nauka, 1965. (In Russian).

A brief review is given of the applications of the Moessbauer effect in studies of superconductors. Isomeric chemical shifts and 5s electron levels in Sn were measured. The use of Moessbauer analyses for determining the transition temperatures is discussed. (R.V.J.)

Plasma and Thermonuclear Physics

Confinement and Heating of Plasma

9523 (LA-3628) STATUS REPORT OF THE LASL CONTROLLED THERMONUCLEAR RESEARCH PROGRAM FOR 12 MONTH PERIOD ENDING OCTOBER 31, 1966. (Los Alamos Scientific Lab., N. Mex.). Nov. 1966. Contract W-7405-eng-36. 147p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Engineering developments are discussed for the Scylla III, Scylla IV, Scyllac, and Scyllacita devices. The plasma properties in each of these devices are briefly described. Research toward application of holography to plasma diagnostics is discussed. Research on the caulked stuffed cusp experiment is outlined. The plasma gun research developments are discussed. In particular, the Mushroom experiments are described. The activities of the theoretical plasma group are summarized. (M.O.W.)

9524 (NASA-CR-657) PRODUCTION OF SUPERHEATED HYDROGEN PLASMA USING INDUCTION HEATING OF COLD PLASMA AND DC PLASMA ENHANCEMENT. Thorpe, Merle L. (Humphreys Corp., Concord, N. H.). Dec. 1966. 18p. CFSTI $3.00 cy, $0.65 mn.

Preliminary experimental investigations were conducted to determine if pure hydrogen could be heated inductively with 25-kW 4-Mc power. Results are presented which demonstrated that 70% hydrogen in argon can be heated, that direct current and rf plasmas can be operated in tandem with the rf energy added to the exit of a dc plasma gun. Other experiments are discussed with recommendations for apparatus necessary to heat pure hydrogen. (auth)

9525 EFFECT OF A HIGH-FREQUENCY ELECTRIC FIELD ON A GLOW DISCHARGE PLASMA. Skhierchynski, Ianush; Zelent, Iuliiush. Biul. Lubelsk. Tow. Nauk., 3-4: 45-9(1963-1964). (In Russian).

An experimental investigation was made on the effects of the d/d_0 ratio (where d and d_0 are the widths of the plasma column in the presence and absence of the field, respectively) on the frequency and amplitude of a rapidly varying electric field. It is found that a sinusoidally varying hf field is capable of confining a glow discharge plasma. Confinement of the plasma is a function of the amplitude and frequency of the applied field. The frequency and amplitude values corresponding to the maximum confinement effect (i.e., the minimum value of the d/d_0 ratio) depend on the voltage of the discharge current and, thus, on plasma density. Amplitudes in excess of the optimum amplitude for a given frequency will disrupt the plasma column. (Int. Aero. Abstr.)

9526 CONTRACTION OF PLASMA IN A LINEAR Z-PINCH TUBE. Ishii, Keishi; Suemitsu, Hidetoshi; Fukuda, Kuniya (Kyoto Univ.). Jap. J. Appl. Phys., 5: 1235-9(Dec. 1966).

The contraction behavior of plasma in a linear z-pinch tube was observed with a streak camera and a spectrograph for initial gas pressure ranging from 0.5 to 20 torr for He and from 0.1 to 20 torr for Ar. The time of initial contraction was determined by measuring discharge current and photoelectric signal of continuum emission from the contracted plasma. The relation between the contraction time τ and the initial gas pressure P_0 can be represented by $\tau \propto P_0^n$ with different n values in three pressure ranges. From the correspondence of the observed contraction behavior and the contraction time in these three pressure ranges it is shown that the contraction mechanism can be described by Rosenbluth's snow plow model in the lowest pressure range and by Allen-Jukes' shock wave model in the intermediate pressure range. (auth)

9527 NEW EXPERIMENTAL RESULTS IN THE RESEARCH ON THE PHYSICAL PRINCIPLES OF CONTROLLED THERMONUCLEAR FUSION. Eckhartt, D.; Keilhacker, M. (Institut fuer Plasmaphysik GmbH, Garching, Ger.). Naturwissenschaften, 53: 571-81(Nov. 1966). (In German).

The latest experimental results on controlled thermonuclear fusion are reviewed. Plasma in magnetic fields, plasma heating by fast magnetic compression, and plasma input in toroidal installation are considered. (J.S.R.)

9528 ROTATING PLASMA EXPERIMENTS IN THE B-3 STELLARATOR. Gorman, J. G.; Rietjens, L. H. Th. (Princeton Univ., N. J.). Phys. Fluids, 9: 2504-17(Dec. 1966). (MATT-342).

A radial electric field can be imposed on the plasma column of a stellarator by means of a comparatively large, positively biased Langmuir probe. Measurements are presented which confirm the theoretical description of the resulting $E \times B$ rotation in terms of a leaky plasma capacitor; the leakage is caused most likely by resonant charge exchange collisions with neutral atoms. The plasma loss rate is changed in the rotating region; a decrease in loss rate by a factor 8 can be realized; too large a rotational velocity causes the loss rate to increase again. Comparisons are made with other experiments and theories. The experiments were carried out in highly ionized hydrogen and deuterium plasmas created by Ohmic heating in the B-3 stellarator, having electron temperatures of 3 to 5 eV, densities of 2 to 20×10^{12} cm^{-3}, and confined in magnetic fields of 25 to 40 kG. An experimental justification for the interpretation of Langmuir probe characteristics under these conditions is given. (auth)

9529 PARTICLE LOSS IN A THREE-DIMENSIONAL CUSP. Grossmann, William Jr. (New York Univ.). Phys. Fluids, 9: 2478-85(Dec. 1966).

The loss of particles through an axisymmetric cusped magnetic field containment geometry is considered. An appropiate adiabatic invariant is derived for the plasma considered to be a high-β, collisionless collection of particles contained within a field-free region bounded by a mathematically sharp interface. The particles are allowed to undergo soft collisions with the interface thus giving rise to a boundary layer. A velocity space loss cone criterion analogous to the loss cone criterion in magnetic mirror machines is derived. Particle loss rates are calculated for a special form of the particle distribution function, and the results are compared with relevant experimental data. A previous treatment of the present problem considering two-dimensional geometry is re-examined in view of the present work concerning adiabatic invariance. (auth)

9530 EXPERIMENTAL INVESTIGATION OF SINGLE INTERACTION NONADIABATIC LOSSES FROM AXISYMMETRIC MAGNETIC MIRRORS. Roth, J. Reece (Lewis Research Center, Cleveland). Phys. Fluids, 9: 2538-40(Dec. 1966).

The magnetic field strength, mirror ratio, and particle energy responsible for the onset of single-interaction nonadiabatic losses were found to be correlated by a power-law similarity relation, if they are expressed in terms of certain dimensionless parameters. (auth)

9531 END LOSSES FROM A LINEAR θ-PINCH. Morse, Richard L. (Los Alamos Scientific Lab., N. Mex.). Phys. Fluids, 9: 2536-8(Dec. 1966). (LA-DC-8137).

End losses from a linear θ-pinch are estimated from a self-consistent calculation of the structure of the plasma and the confining magnetic field. (auth)

9532 WAVE-EXCITED ANOMALOUS DIFFUSION IN A FULLY IONIZED MAGNETOPLASMA. Eastlund, B. J.; Josephy, K.; Leheny, R. F.; Marshall, T. C. (Columbia Univ., New York). Phys. Fluids, 9: 2400-7(Dec. 1966).

The transverse diffusion coefficient $D_\perp$ of a fully ionized plasma in a Q machine was observed to depend on the frequency and amplitude of low-frequency (kilocycle) waves. These waves, observed with a floating Langmuir probe and spectrum analyzer, could be impressed on the plasma (1) by a weak electron beam injected along the plasma axis, (2) by applying an ac signal of appropriate

frequency to a plate at one end of the plasma, or (3) were found to occur naturally. $D_\perp$ was determined from the radial profile of potassium plasma pulses. In all cases, $D_\perp$ was strongly influenced by the amplitude of the low-frequency components of the spectrum and was observed to be proportional to the rms power of the fluctuations. The impedance of the plasma as a function of the impressed ac signal showed minima at frequencies close to that of the "drift instability," where the value of $D_\perp$ exhibited strong maxima. (auth)

9533 NEGATIVE MASS INSTABILITY. Landau, Ronald W.; Neil, V. Kelvin (Univ. of California, Livermore). Phys. Fluids, 9: 2412-27(Dec. 1966).

A canonical formalism has been developed for the description of the negative mass instability. The formalism has been applied to the formulation of a kinetic equation which is solved by the method of characteristics (or integration over orbits). It is found that a spread in betatron oscillation amplitudes contributes to stability, in addition to the spread in the canonical angular momentum. The negative mass instability equation for two streams is also obtained, and the result is the same as though each stream were present separately. It is also shown that the linear two-stream equation does not apply for a circular beam geometry; instead, the negative mass instability two-stream equation applies. (auth)

9534 MULTIPLE SCATTERING OF PARTICLES IN A MAGNETIC FIELD WITH RANDOM INHOMOGENEITIES. Dolginov, A. Z.; Toptygin, I. N. (Ioffe Inst. of Physics and Tech., Leningrad). Zh. Eksp. Teor. Fiz., 51: 1771-83(Dec. 1966). (In Russian).

Motion of charged particles in a magnetic field with regular or random components is considered. A kinetic equation for the particle distribution in such a field is derived under the assumption that the magnetic field inhomogeneities move with a certain velocity. It is assumed that in this case deviation of the particles by a random field over the correlation length is small. A solution of the kinetic equation is obtained for some particular case. Transition to the diffusion approximation is considered and the equation for diffusion of particles in a medium with moving magnetic field inhomogeneities is derived. (auth)

9535 ADIABATIC CHARGED PARTICLE MOTION. Northrop, Theodore G. (Goddard Space Flight Center, Greenbelt, Md.). pp 21-47 of Plasma Physics in Theory and Application. Kunkel, Wulf B. (ed.). New York, McGraw-Hill Book Co., 1966.

A theoretical discussion of adiabatic charged particle motion is presented in terms of the following: the guiding-center motion of nonrelativistic particles, energy changes, Fermi acceleration, relativistic adiabatic motion, the adiabatic invariants, application of adiabatic theory to plasmas, and nonadiabatic effects. (M.O.W.)

9536 DISSIPATIVE EFFECTS. Kaufman, Allan N. (Univ. of California, Berkeley). pp 91-117 of Plasma Physics in Theory and Application. Kunkel, Wulf B. (ed.). New York, McGraw-Hill Book Co., 1966.

Plasma diffusion in magnetic fields is discussed as follows: linear-transport relations, equations of change, local equilibrium, and anomalous effects. (M.O.W.)

9537 CONTROLLED THERMONUCLEAR FUSION. Pyle, Robert V. (Univ. of California, Berkeley). pp 453-69 of Plasma Physics in Theory and Application. Kunkel, Wulf B. (ed.). New York, McGraw-Hill Book Co., 1966.

A survey of the various considerations which must be dealt with in a controlled thermonuclear fusion program is presented. Such things as the nuclear reactions involved, general plasma parameters, the confinement system, and plasma production and heating methods, are discussed. (M.O.W.)

9538 AZIMUTHAL DRIFT OF CHARGED PARTICLES IN AXIALLY-SYMMETRIC MAGNETIC FIELD WITH MIRRORS. Balebanov, V. M.; Semashko, N. N. At. Energ. (USSR), 21: 500-1(Dec. 1966). (In Russian).

A series of equations for charged particle motion in mirror traps with symmetric magnetic fields was used previously for developing, in drift approximation, expressions for angular drift velocity. Observations of numerous mirror reflections revealed the Larmor radius magnitude ρ_0 and, respectively, the parameter β at which the deflection from the drift theory takes place. Electron drift in a magnetic field of Ogra-1 type, with optimum positive drift, was studied in order to find the points of deflection. The measurements were made using an Ogra electron model, with the coefficient of similitude 1:7, with short-pulse (0.5 μ sec) electron injections at 20°. Typical oscillograms for azimuthal drift periods were constructed. (R.V.J.)

9539 DEVICE FOR CONTAINMENT OF THE PLASMA. Kondo, Hiromichi (to Mitsubishi Electric Mfg. Co., Ltd.). Japanese Patent 1966-6000. Mar. 30, 1966. Filed Nov. 29, 1963.

An improvement was performed on a plasma containment device, which employs cusp magnetic fields for containing a high-temperature plasma. The basic cusp magnetic field is produced by flowing an electric current opposite in the direction through the adjoining conductors, which are arranged in parallel with one another at the suitable intervals. And another cusp magnetic field is formed by another group of conductors. The two groups of conductors are so arranged that the cusp ends of the former magnetic field, and of the latter do not overlap with each other. (NSA of Japan)

Diagnostics of Plasma

Refer also to abstracts 8521, 8646, 9397, 9523, and 9612.

9540 (JUL-413-PP) MESSUNGEN DER KONTINUUMSSTRAHLUNG EINES THETAPINCHPLASMAS ZWISCHEN 4000 UND 6000 A UND ZWISCHEN 5 UND 20 A ZUR UNTERSUCHUNG DER AUFHEIZUNG DER ELEKTRONEN. (Measurement of the Continuum Radiation of a Theta Pinch Plasma Between 4000 and 6000A and Between 5 and 20A for Investigation of the Heating of Electrons). Schlueter, J. (Kernforschungsanlage, Juelich (West Germany). Institut fuer Plasmaphysik). Sept. 1966. 72p. (In German). Dep. mn.

Experiments are described in which the continuum radiation emitted by a very high-temperature plasma was investigated. The center of gravity of the measurements lay in the area of soft x rays. The plasma was produced by means of a θ-pinch apparatus. The electron heating could be based on a series of mechanisms, which were investigated. Therefore, a knowledge of the time behavior and the spatial distribution of the electron temperature was necessary. It had to be determined whether or not the velocity distribution of the electrons was thermal; therefore, the spectral pattern of the continuum was measured. The continuum was identified as the bremsstrahlung continuum of H_2. It was concluded that the recombination continua of O VII and O VIII contributed to the continuum observed. The continuum in the area of soft x radiation decreases exponentially with increasing frequency so that a thermal distribution of the electrons results. The maximum electron temperature was about as large as the ion temperature and the temperature calculated from the pressure balance. The heating occurred essentially through energy transfer of the heated ions to the electrons. A vacuum Bragg spectrometer was built for the region of 1 to 25 Å. The most important consideration in the construction was the attainment of a sufficiently scattered light freedom. A permissible method for the detection of the scattered light was developed. (tr-auth)

9541 (UTIAS-120) EXPERIMENTS ON THE APPLICATION OF ELECTRON SCATTERING TO PLASMA DIAGNOSTICS. Battle, E. L. (Toronto Univ. (Ontario). Inst. for Aerospace Studies). Dec. 1966. 136p. Dep. mn.

An experimental apparatus was constructed to test the concept of using Coulomb scattering of injected electron beams as a plasma diagnostic technique. The experimental conditions were chosen to avoid multiple scattering and plasma oscillation coupling with the beam insofar as possible. The data obtained indicated that these effects had been avoided and that the single Coulomb-Rutherford collision model was the proper one for describing the results over the range of electron densities investigated. Extensive validation experiments were conducted to ensure sufficient accuracy of Langmuir probe measurements, which were used for comparison purposes, and the absence of any spurious effects which could influence the beam scattering measurements. Theoretical values of cross sections were derived by averaging the Rutherford results over the length of the interaction zone and over the width of the beam, using experimental data for spatial charge distribution and beam intensity profiles. These values were within 15% of the experimentally measured cross sections. The influence of detector angular resolution and beam energy were also measured and found to be in good agreement with Rutherford theory. It was concluded that it is indeed feasible to use an electron beam for plasma diagnostics. (auth)

9542 DENSITY AND TEMPERATURE OF A LASER-INDUCED PLASMA. David, C.; Avizonis, P. V.; Weichel, H.; Bruce, C.; Pyatt, K. D. (Kirtland Air Force Base, Albuquerque, N. Mex.). IEEE (Inst. Elec. Electron. Eng.) J. Quantum Electron., QE-2: 493-9(Sept. 1966).

The interaction of laser radiation with ablating solid surfaces may result in electronic absorption of optical radiation with consequent vaporization of the material. Further heating of the vapor may then occur, due to molecular absorption, with the eventual ionization of the vapor. The ionized vapor may then be further heated by free-free and bound-free absorption processes, re-

sulting in ionization and reradiation from the plasma. This plasma was studied experimentally and theoretically. Electron densities and plasma optical thicknesses were measured both in time and position resolved manners for plasmas produced from carbon. The ruby laser system consisted of Q-switched oscillator with an energy output between 8 and 13 J in a 0.055-μsec pulse width at half-height. The electron density was measured using a gas laser as a probe light source and a Mach–Zender interferometer to measure the phase shifts due to plasma refractivity. The experiments were performed with incident laser energies of 10 to 1000 J/cm^2 (by focusing). Electron densities as high as 10^{19} cm^{-3} were observed, with correspondingly high plasma optical thicknesses. There were strong indications of heating by the incident laser beam of the front edge of the plasma, which was not expected on the basis of plasma heating by free–free and bound–free absorption due to the low electron density existing there. In general, a theoretical treatment of plasma heating by the bound–free and free–free absorption agreed well with experiments. (BBB)

9543 SPECTROSCOPIC STUDIES OF LASER-PRODUCED HYDROGEN PLASMA. Litvak, M. M.; Edwards, D. F. (Lincoln Lab., Lexington, Mass.). IEEE (Inst. Elec. Electron. Eng.) J. Quantum Electron., QE-2: 486-92(Sept. 1966).

A dense plasma can be produced by focusing a giant-pulsed ruby laser in a gas at moderately high pressure. Time-resolved spectroscopic measurements were made of the decay of a laser-produced discharge in H over a range of pressures from 1 to 70 atm. The plasma temperature, which ranged from about 10^5 to 10^4°K during the Q-switched laser pulse to several microseconds afterward, was obtained from the ratio of the intensity of H_α to that of nearby continuum radiation. The electron density, which ranged from about 10^{19} to 10^{17} per cm^3, was obtained from the time history of the Stark linewidths of H_β. Since the high collision rates ensured approximate local thermodynamic equilibrium, several important characteristics of the plasma could be calculated from the measured temperature and density, such as optical absorption at the laser frequency due to inverse bremsstrahlung and photoionization. The energy deposited by the laser was measured from the decrease of the transmitted laser beam. Scattered radiation seemed small. The observed laser absorption was about 2 orders of magnitude larger than that calculated for a Maxwellian electron distribution. The calculated line absorption for H_α was consistent with self-absorption observed in the H_α spectral profile. The ratio of the measured watts of H_α to the calculated W/cm^3 yielded values for the volume of the luminous region which generally decreased with gas pressure from 10^{-3} to 10^{-4} cm^3, as observed. (BBB)

9544 PROBE MEASUREMENTS ON DISCHARGES. PART I. DC PROBE MEASUREMENTS. Bito, Janos (Industrial Research Inst. for Communications Technology, Budapest). Magyar Fiz. Foly., 14: 185-222(1966). (In Hungarian).

The probe technique developed by I. Langmuir and H. M. Mott is one of the best methods for the determination of the discharge microparameters and distributions during dc discharges; however, even though it has been improved considerably during the years, its general application is limited by the occasionally occurring specific magnetic field of the discharge and by the concentration relations of hot plasmas. After a review of Langmuir's ideal probe characteristics, the determination of specific properties were examined, including the determination of the Maxwell–Boltzmann and Druyvesteyn distributions. The individual probe states were derived from the fundamental gas-kinetic equations; problems arising from the use of two or more probes were discussed on the basis of Poisson's equation. When using cylindrical or spherical probes, correction factors or graphic approximation methods must be used. Keeping in mind the limitations of the method, probe measurements of dc discharges were considered to yield good information on the plasma potential, wall potential, and energy distribution of the charge carriers. (TTT)

9545 PLASMA CAPACITOR IN A MAGNETIC FIELD. Crawford, F. W.; Mantei, T. D.; Tataronis, J. A. (Stanford Univ., Calif.). Int. J. Electron., 21: 341-51(Oct. 1966).

Previous work is extended on the impedance of a parallel plate capacitor, filled with warm plasma, to take account of a static magnetic field. Computations are presented for parallel plate and coaxial cylinder geometries and indicate series of resonances occurring at, and between, the electron cyclotron frequency harmonics. It is suggested that if the theoretical results were confirmed experimentally, plasma admittance measurements would form the basis of a simple and powerful diagnostic technique for measuring plasma parameters such as electron density and temperature in the laboratory and in the ionosphere. (auth)

9546 LASER INTERFEROMETRY AS A MEASURE OF TURBULENT FLUCTUATIONS. Guthart, H.; Scharfman, W. E. (Stanford Research Inst., Menlo Park, Calif.). Phys. Fluids, 9: 2525-7(Dec. 1966).

The power spectral density of the integrated neutral particle density fluctuations in the turbulent exhaust of a sonic jet has been measured using a laser interferometer. The measurements are compared with calculations of the power spectral density function. (auth)

9547 ION CYCLOTRON RESONANCE IN A DENSE PLASMA WITH HOT ELECTRONS. Dubovoi, L. V.; Dyatlov, V. D.; Fedyakov, V. P. JETP Lett. (USSR) (Engl. Transl.), 4: 263-6 (Nov. 15, 1966).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Redaktsiyu, 4: 388-93(Nov. 15, 1966).

Results are reported of an experimental investigation of the properties of a dense plasma with preheated electrons in the ion cyclotron resonance region. The experiments were made in a magnetic mirror trap. The electrons were heated by a direct turbulent discharge. The plasma absorption and decay properties for various mirror ratios are given. (M.O.W.)

9548 METHOD OF DETERMINATION OF PLASMA PARAMETERS BASED ON MEASUREMENTS OF REFLECTION COEFFICIENT. Zakrzewski, Z. (Inst. of Flow Machines, Danzig). Bull. Acad. Pol. Sci., Ser. Sci. Tech., 14: 51-4(1966).

Introduction of plasma into a waveguide causes a reflected wave. The reflection coefficient may be calculated if the equivalent circuit of the region occupied by plasma is known. The reflective properties are described for a cylinder of uniform, isotropic plasma with electron density N and the effective electron-neutral particle collision frequency ν. (M.O.W.)

9549 RADIAL DENSITY PROFILE IN A POSITIVE COLUMN WITH A LONGITUDINAL MAGNETIC FIELD. Itoh, Satoshi; Kawaguchi, Motoichi; Yamamoto, Kenzo (Univ. of Nagoya, Japan). Phys. Fluids, 9: 2535-6(Dec. 1966).

The radial density profile is investigated experimentally and compared with the theoretical results of Holter and Johnson. The experimental results agree qualitatively with the theoretical ones under some experimental conditions. (auth)

9550 SIMPLE 4 MM MICROWAVE RECEIVER FOR PLASMA SCATTERING EXPERIMENTS. Hotston, E. S. (United Kingdom Atomic Energy Authority, Abingdon, Eng.). J. Sci. Instrum., 44: 47-9(Jan. 1967). (CLM-P-112).

A microwave receiver working in the 4-mm bond was developed for use in plasma scattering experiments. The receiver has a bandwidth of 6 Mc and an integrating time of 1 μsec. The measured sensitivity (unity signal-to-noise ratio) was 2×10^{-10} W. This sensitivity could be improved by a factor of 1200 as the result of component development. The receiver is simple in construction and does not require a separate local oscillator. (auth)

9551 SPECTROSCOPIC MEASUREMENTS IN FLUCTUATING ARCS. Lee, D. A.; Garscadden, A. (Aerospace Research Labs., Wright-Patterson AFB, Ohio). J. Opt. Soc. Amer., 56: 1698-1700(Dec. 1966).

A quantitative treatment of the error due to fluctuations of electron thermal energy in the measurement of mean electron temperature by the line-intensity ratio is given. It is found that whatever the functional form of the fluctuations may be, there is an optimum ratio $\Delta E/kT_e = 2$ for which this error varies as the fourth power of the fluctuation amplitude and is consequently small. For all other values of $\Delta E/kT_e$, the temperature error due to fluctuations is quadratic in the fluctuation amplitude, and rapidly approaches contemporary estimates of errors due to other causes as the relative amplitude of the temperature fluctuations increases toward 50%. (auth)

9552 EXTENSION OF MEASURABLE DENSITY RANGES IN MICROWAVE PLASMA DIAGNOSTICS. Takeda, Susumu; Masumi, Motoshi (Nagoya Univ., Japan). Jap. J. Appl. Phys., 5: 1100-6(Nov. 1966).

In order to apply microwaves for measuring the time-varying electron densities down to their low values in gaseous plasma, a technique was developed, which can increase the small phase difference between the microwaves transmitted through a path with and without plasma by means of a dielectric plate of $\frac{1}{4}$ wave length thickness. By using two dielectric plates, the electron density lower by at least one order of magnitude than that measured by the previous method is measured in a decaying afterglow plasma in a waveguide. The sensitivity of this method is comparable to that by a cavity technique which is sensitive particularly in measuring low plasma densities but is not always convenient in probing plasmas in free space. The present system, however, has a wide application even in plasmas in free space, if a doubled path is established with a reflector. In addition, this technique has another advantage that the sensitivity can

be changed by a simple procedure. The electron density from 10^8 to 10^{18} cm^{-3} for a plasma of one wave length thickness is detectable by the present technique at an X-band (9000 Mc) microwave frequency. (auth)

9553 ASYMPTOTIC THEORY OF ELLIPSOIDAL ELECTROSTATIC PROBES IN A SLIGHTLY IONIZED, COLLISION-DOMINATED GAS. Cohen, Ira M. (Brown Univ., Providence, R. I.). AIAA (Amer. Inst. Aeronaut. Astronaut.) J., 5: 63-9 (Jan. 1967).

The analysis of Langmuir probes, which are ellipsoids of revolution, immersed in an infinite, homogeneous, slightly ionized, collision-dominated plasma, is given in the limiting situation: mean free path $\ll$ Debye length at sheath edge $\ll$ semiminor axis of probe. The neutral gas is assumed to be uniformly distributed, and production or recombination of charged particles is neglected except on the probe surface (where all charged particles recombine). In the limit of small Debye length compared with probe size, the diffusion equations and Poisson's equation (for the self-consistent electric field) split into two regions: a quasi-neutral region and a thin space charge sheath wrapped around the probe. The equations are solved in both regions and asymptotically matched to each other. Current–voltage characteristics are computed from integrals of the solutions and emphasis is placed on their interpretation with respect to measurements. The effect of variation of the ratio of major to minor axes on the current collected by the probe also is made clear. (auth)

9554 COOLED ELECTROSTATIC PROBE. Grey, Jerry; Jacobs, Paul F. (Princeton Univ., N. J.). AIAA (Amer. Inst. Aeronaut. Astronaut.) J., 5: 84-90 (Jan. 1967).

Experiments were performed to evaluate the ability of a water-cooled electrostatic probe to measure local electron temperature, electron density, floating potential, and saturation current ratio in dense plasmas (argon up to 20,000°R at 1 atm). The measurements of electron temperature were calibrated against temperatures obtained from simultaneous local measurements of total plasma enthalpy at different temperatures under conditions of known equilibrium by use of a proven calorimetric probe technique and were found to be in agreement within normal experimental error (3% standard deviation from the mean). Using this electron temperature, the measurements of floating potential and saturation current ratio were found to agree with a first-order theoretical approximation to within the accuracy of the approximation. The cooled calorimetric–electrostatic probe was then used to measure the degree of nonequilibrium in a reduced-pressure argon plasma in terms of the difference between local electron and heavy-particle temperatures. Results were in agreement with analytical predictions of a simple "freezing" criterion. The probe also provided a semiquantitative measurement of plasma turbulence. (auth)

9555 MEANS FOR MEASURING PLASMA DENSITY BY RESONANT CHARGE TRANSFER WITH A BEAM OF NEUTRAL PARTICLES. Eubank, H. P. (to U. S. Atomic Energy Commission). U. S. Patent 3,300,640. Jan. 24, 1967.

This patent measures the density of a magnetically confined column of plasma by directing a beam of neutral particles across the column whereby there is resonant charge transfer between the particles of the beam and the plasma column and a resultant attenuation of the beam in traversing the plasma that corresponds to the plasma density. In one embodiment the resultant beam is converted into an electrical signal corresponding to the plasma density by a system producing secondary electrons from the resultant beam and detecting these electrons in a scintillator photomultiplier. (AEC)

Kinetics of Plasma

Refer also to abstracts 9354, 9523, and 9635.

9556 (AD–642161) COLLISIONS IN IONIZED GASES. Lewis, Jordan D. (Michigan Univ., Ann Arbor. Dept. of Nuclear Engineering). Oct. 1966. Contract DA-31-124-ARO(D)-403. 168p. (AROD–6092:6). CFSTI $3.00 cy, $0.65 mn.

Particle interactions in ionized gases are described and their effects mathematically treated. The principal results are: (1) An expansion theorem for the linearized Fokker–Planck collision operator for each component of a two-component fully ionized gas, and (2) A description of photon scattering from a partially ionized gas. It is shown that the Fokker–Planck collision operator generates a complete, continuous set of velocity–space eigenfunctions, for which high-speed asymptotic forms are found. Since the set is continuous, the expansion formula has the form of a generalized Fourier integral. The effect of neutral atoms on the spectrum of photons scattered by electrons in a partially ionized gas is shown to be primarily a reduction in height and increase in width of the two electron-plasma "wings." The scattered photon spectrum is described for several characteristic cases. (auth)

9557 (AD–643808) ON THE LOGARITHMIC DENSITY BEHAVIOR OF A NONEQUILIBRIUM BOLTZMANN GAS. Goldman, Robert; Frieman, Edward A. (Princeton Univ., N. J. Plasma Physics Lab.). Sept. 1966. Contract AF 49(638)-1555. 57p. (PPL-AF-7). CFSTI $3.00 cy, $0.65 mn.

The temporal evolution of the B-B-G-K-Y hierarchy in the Boltzmann approximation for spatially homogeneous nonequilibrium situations is considered, in the absence of initial correlations. For times of the order of the mean free time or greater, the single particle function, f_1, is found to be of the form: $f_1 = f_1^0 + \epsilon f_1^1 + \epsilon^2|\ln\epsilon|\,\tilde{f}_1^1 + 0(\epsilon^2)$ with $\epsilon = nr_0^3$ (n = density, r_0 = range of binary interaction) and f_1^0, f_1^1 and $\tilde{f}_1^1$ of order unity. For times less than the mean free time, with t in units of the duration of a binary interaction, f_1 is of the form: $f_1 = f_1^0 + \epsilon f_1^1 + \epsilon^2(\text{lnt})\,\tilde{f}_1^1 + 0(\epsilon^2)$. In both cases the same formally higher order binary correlation functions are neglected. (auth)

9558 (AFCRL–66-752) INVESTIGATIONS OF BASIC PROPERTIES OF GASEOUS PLASMAS. Final Report, August 1, 1963–July 31, 1966. Goldstein, L. (Illinois Univ., Urbana. Gaseous Electronics Lab.). Oct. 1966. Contract AF 19(628)-3307. 7p.

A brief description of studies on gaseous plasmas at cryogenic temperatures, and of active discharge plasmas, is presented. The results of these studies were published elsewhere. (M.O.W.)

9559 (CEA-R-3000) RESULTATS EXPERIMENTAUX SUR BILLE EN TETE "A". 1ERE PARTIE. COLLISIONS EN CHAMP MAGNETIQUE HOMOGENE. 2EME PARTIE. COLLISIONS EN BOUTEILLE MAGNETIQUE A MIROIR. (Results Obtained From the "Bille en Tete A" Experiment. Part 1. Collisions in Homogeneous Magnetic Field. Part 2. Collisions in Magnetic Mirror Bottle). Evrard, Paul; Jacquinot, Jean; Leloup, Christian; Poffe, Jean-Pierre; Waelbroeck, Francois (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). 1966. 62p. (In French). (EUR-2792.f). Dep. mn.

Collisions of plasma puffs, whose characteristics (density and velocity) were varied in a broad domain are studied in a homogeneous longitudinal magnetic field. It has been verified that the puffs meet head on. It is shown that collisions of dense ($n_i \geq 4.10^{14}$ cm^{-3}) and relatively slow ($v_0 \leq 10^7$ cm.s) puffs are "efficient," i.e., the initial kinetic energies of the puffs are converted into thermal energy of the ions in the resulting plasma. Faster and less-dense puffs interact little: incomplete conversion of kinetic into thermal energy. The limit between efficient and inefficient collisions corresponds to that which is expected from the test particle model. The slowing down of the puffs is thus ensured mainly by particle–particle interactions. The use of electric probes and the examination of the evolution of the plasma produced by the collision show that this plasma does not exhibit any rapid radial motion. In the magnetic bottle of Bille-en-Tête A (mirror ratio 4000/2000 G), the collision of two low-density puffs leads to the capture of one liter of plasma with a density $n_i \approx 2.10^{13}$ cm^{-3} and an ionic temperature $T_i \approx 10^6$ °K. The e-folding time of the plasma diamagnetism reaches 50 to 150 μs; no flute instabilities are detected. The T_i evolution was measured by the Doppler broadening of the 4686 Å line of the He^+ (added to the injected D^+ in the proportion of 5 per cent and the relative evolution of n_i by the intensity of the spectral continuum. T_i decreases rapidly, reaches 5.10^5 to 10^5 °K, respectively, 15 and 120 μs after the maximum of the collision diamagnetic signal; n_i increases slowly, 25% during the first 100 μs after the collision. The presence of cold plasma beyond the mirrors of the bottle allows one to justify the energy losses (thermal conductivity) and the apparent stability of the plasma column. (auth)

9560 (NASA-CR–660) HOLLOW CATHODE PLASMA PENETRATION STUDY. Russell, Graham; Litton, James; Myers, P. B. (Bunker-Ramo Corp., Canoga Park, Calif.). Dec. 1966. Contract NAS 12-9. 41p. CFSTI $3.00 cy, $0.65 mn.

The investigation was made to determine whether the electron beam mode discharge is suitable for penetrating the plasma sheath surrounding a reentering vehicle and providing communications. The discharge is formed by a conventional hollow cathode with a perforated wall. This configuration will discharge in a mode providing an ion-collimated electron beam. This beam is stable over a wide range of pressures and voltage. In addition, coherent microwave radiations from the beam have been observed. A summary of past research is presented. The results of a study to develop a model for the coherent microwave radiations are presented. (M.O.W.)

9561 (NASA-CR-54762) MAGNETIC INDUCTION PLASMA ENGINE. Final Report. Heflinger, Lee; Ridgway, Stuart; Schaffer, Allan (General Technology Corp., Los Angeles, Calif.). Apr. 5, 1965. Contract NAS 3-5912. 79p.

Research is described which covers the final phase in a magnetic induction plasma accelerator development program. The aim of this development program has been to develop an engine that accelerated a plasma to a velocity corresponding to a specific impulse of 3000 seconds, or more, with good efficiency. Good accelerative coupling had been demonstrated in the previous work between helium plasma and a traveling transverse 450-G magnetic field, but with excessive wall interaction. The wall interaction was not significantly reduced by the changes in magnetic field geometry investigated. A theoretical study of the interaction suggests potential improvement by shortening the accelerator. (auth)

9562 (SC-DC-66-2266) VELOCITY MEASUREMENTS IN A PLASMA ARC TUNNEL WITH A SPARK-INJECTION TECHNIQUE. Schelby, Frederick (Sandia Corp., Albuquerque, N. Mex.). Sept. 1966. Contract AT(29-1)-789. 14p. (CONF-660940-1). DTIE.

From 26th Supersonic Tunnel Association Meeting, Moffett Field, Calif.

Free stream velocities in a 160 kw Arc Tunnel were obtained by measuring the time of flight of repetitive spark discharges in the flow. The velocity data are presented as a function of total enthalpy. (auth)

9563 (TID-23490) STEADY-STATE THEORY OF A LOW-PRESSURE DISCHARGE COLUMN IN AN AXIAL MAGNETIC FIELD. Technical SUIPR Report No. 104. Self, S. A. (Stanford Univ., Calif. Inst. for Plasma Research). Oct. 1966. Contract AT(04-3)-326. 30p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

A steady-state theory of a low-pressure discharge column in a magnetic field is derived in terms of the moments of the Boltzmann equation. For the electrons, the first two moment equations are used with a scalar pressure. For the ions the first three moment equations are used with an adiabatic assumption. Numerical solutions are given for the profiles of velocity, potential, density, and ion stress tensor for both planar and cylindrical geometry for ranges of the parameters of practical interest. A discussion is given of the application of the theory to experimental situations. (auth)

9564 (TID-23497) ENTROPY PRINCIPLE FOR THE DERIVATION OF A NEW CLUSTER EXPANSION. Dawson, J. M.; Kruskal, M. D.; Ramanthan, G. V. (Princeton Univ., N. J. Plasma Physics Lab.). Sept. 1966. Contracts AT(30-1)-1480; AF 49(638)-1555. 12p. (PPL-AF-10). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

A product expansion for the s-particle distribution function (s arbitrary) is derived by means of a variational principle involving the entropy associated with the (s + 1) particle distribution function. (auth)

9565 (UCRL-14466(Rev.1)) DYNAMICS OF A GYROVISCOUS PLASMA. Newcomb, William A. (California Univ., Livermore. Lawrence Radiation Lab.). June 28, 1966. Contract W-7405-eng-48. 30p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

A collisionless plasma in a strong magnetic field is well known to exhibit a reactive type of viscosity (as opposed to a resistive type), which will be referred to here as the gyroviscosity. A systematic dynamical theory is developed for the gyroviscous plasma. For continuous fluids in general, and for plasmas in particular, there are two natural ways of defining the fluid velocity. There is first the observed velocity of a test particle, say a radioactive tracer ion, which presumably is carried along with the fluid, and there is also the momentum per unit mass, with electromagnetic corrections if necessary. In the case of the gyroviscous plasma these two velocities are not the same, but they are related to each other in a symmetrical way. There is, in short, a duality theorem according to which the dynamical equations are invariant under the exchange of the two velocities, if at the same time the direction of the magnetic field is reversed. From this one can derive a number of interesting consequences: (1) There are two types of localized perturbations that are carried along with the moving plasma. One type goes with the one velocity and the other type with the other. Both velocities, therefore, can in principle be observed and measured directly. (2) There are two independent energy integrals. (3) It is a sufficient condition for the stability of a plane parallel flow that the two velocities, in some suitably chosen reference frame, be everywhere opposite in direction. There is a third natural velocity midway between the other two. If the dynamical equations are written in terms of this third velocity, then the gyroviscous force is derivable from a potential-energy function. In this formulation, the equations are the same as those of a non-gyroviscous plasma with an extra stabilizing B field. (auth)

9566 (UCRL-14558(Rev.1)) SOME PROBLEMS IN THE COMPUTER SIMULATION OF MOBILITY MEASUREMENT EXPERIMENTS AND OTHER ION SWARM EXPERIMENTS. Barnes, William S. (California Univ., Livermore. Lawrence Radiation Lab.). Nov. 30, 1966. Contract W-7405-eng-48. 19p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

In cases where it is not expedient to eliminate the first-order or mobility term from the mobility-diffusion equation by a transformation of coordinates, the finite difference approximation, $(N_m - N_{m-1})/\Delta x$, of the first-order derivative introduces an artificial second-order or diffusion effect in the difference equation solution of this partial differential equation. It is shown that this effect may be removed by replacing D, the coefficient of the second-order term, by $D - (V/2)(\Delta x - V\Delta t)$, where V is the coefficient of the first-order term. The solution of the modified difference equation is shown to approach the analytical solution asymptotically for an initially closely localized ion distribution, and the ion distribution is shown to have the same variance as the analytical solution throughout the calculation. The additional restrictions on zone size and time step size necessitated by this modified differencing scheme are discussed. The modified differencing scheme can be seen to be "symmetric", i.e., it works equally well for positive or negative values of V. An alternative scheme, the use of a travelling Eulerian reference frame, which removes or reduces this artificial diffusion effect, is also considered. A "typical" problem is solved to illustrate and compare several of the computational schemes discussed. (auth)

9567 (UTIAS-122) SUPERSONIC FLOW OF INVISCID COMPRESSIBLE PLASMAS WITH A FINITE TENSOR CONDUCTIVITY IN THE PRESENCE OF AN EXTERNAL MAGNETIC FIELD. Shih, Lung Yu (Toronto Univ. (Ontario). Inst. for Aerospace Studies). Sept. 1966. 91p. Dep. mn.

A method of determining the macroscopic interaction between the motion of a compressible plasma and electromagnetic fields has been developed. The plasma is considered as an electrically conducting fluid with finite conductivity. The viscosity and heat conduction are neglected. The effects of Hall current and ion slip are considered. The flow under consideration is supersonic and for the practical calculations cases are selected in which a finite expansion around a sharp corner is present. Cases are considered in which the magnetic Reynolds number, although small, cannot be assumed to be zero. The procedure used is based upon a method of successive approximations and is capable of giving solutions for the effect of the induced magnetic field. The entire system of fundamental equations for electromagnetohydrodynamics may be separated into three subsystems: the hydrodynamic, the electric, and the magnetic systems. Since the flow under consideration is supersonic, the method of characteristics has been used for the solution to the hydrodynamic system. Because the magnetic system is elliptic with an unbounded domain, it is solved by means of the method of an integral operator derived through the Green's function. The domain for the electric system is bounded, the Hall current and the related physical quantities may be solved by the relaxation method. Numerical computations have been made for both two-dimensional and axisymmetric models for cases in which the flow first expands around a sharp corner, then flows through a divergent duct with insulated walls. The applied magnetic field is parallel to the undisturbed upstream flow direction. (auth)

9568 SINGULARITY IN THE POWER CARRIED BY THE SURFACE WAVES ALONG AN AXIALLY MAGNETIZED PLASMA COLUMN. Yip, G. L. (Univ. of Toronto); Seshadri, S. R. Proc. IEEE (Inst. Elec. Electron. Eng.), 54: 2030-1(Dec. 1966).

An axially oriented point source of electric current situated on the axis of an infinitely long and axially magnetized plasma column surrounded by free space is considered. In general, both space waves and guided waves are excited. The special behavior of the guided waves is discussed. (M.O.W.)

9569 FREE-FALL DIFFUSION IN A DISCHARGE AFTERGLOW. Gregory, B. C. (Trent Univ., Peterborough, Ont.). Can. J. Phys., 44: 2615-30(Nov. 1966).

The afterglow decay of the number density and electron temperature of a plasma in which collisions between electrons and molecules are rare is studied both theoretically and experimentally. The theoretical approach, using the first three moment equations solved in a one-dimensional geometry, predicts nonexponential decay profiles in time for both density and temperature. Experimental results are obtained using a cylindrical mercury vapor discharge tube at pressures where the mean free path of the electrons is much larger than the transverse dimensions of the tube. The average electron number density is mea-

sured by a surface-wave cavity method and the electron temperature by means of Langmuir probes. The theoretical and experimental results are in good agreement, especially for the density decay. (auth)

9570 LIGHT SOURCE INVESTIGATION BASED ON BREAKING OF PULSE DISCHARGE SUPERSONIC JETS. Snopko, V. N.; Kiselevskii, L. I. Zh. Prikl. Spektrosk. Akad. Nauk BSSR, 5: 421-5(Oct. 1966). (In Russian).

It is shown that the shock compressed plasma layer formed by running a supersonic plasma jet of a pulsed discharge over a fixed barrier can serve as a source of a continuous spectrum with a blackbody energy distribution. The brightness temperature of the source varied from 9000 to 19000°K. (auth)

9571 ASYMMETRIC CO-OPERATIVE SCATTERED LIGHT SPECTRUM IN A THETATRON PLASMA. Evans, D. E.; Forrest, M. J.; Katzenstein, J. (United Kingdom Atomic Energy Authority, Abingdon, Eng.). Nature, 212: 21-3(Oct. 1, 1966). (CLM-P-113).

In an experiment designed to display the ion term in the light scattering cross section of a plasma, a spectrum of scattered light was observed which was asymmetrically distributed about the incident-light wavelength. The experiment was conducted on the Maggi II thetatron operating at 30 kV with an initial gas pressure of 50 mtorr of hydrogen. A Korad KQ-1 giant pulse ruby laser delivering 50-MW pulses was used to obtain a narrow emission line, and the dispersing element at the detector was a pressure scanned Fabry–Perot interferometer which had a free spectral range of 2.55 Å. (W.D.M.)

9572 CURRENT DENSITY DISTRIBUTION IN AN MHD CHANNEL IN PRESENCE OF HALL EFFECT. ANALYTICAL DESCRIPTION AND COMPARISONS WITH EXPERIMENTAL DATA. Kaidalov, V. A.; Tolmach, I. M. Izv. Akad. Nauk SSSR, Energ. Transp., No. 5, 93-5(Sept.-Oct. 1966). (In Russian).

An analytical solution is derived for the distribution of plasma current density in a two-electrode MHD channel usable either for accelerator or generator operations. An expression is developed for the constant found in the solution, taking into account the emf. The calculations are compared with experimental data. (tr-auth)

9573 VELOCITY SPACE DIFFUSION FROM WEAK PLASMA TURBULENCE IN A MAGNETIC FIELD. Kennel, C. F.; Engelmann, F. (International Centre for Theoretical Physics, Trieste, Italy). Phys. Fluids, 9: 2377-88(Dec. 1966).

The quasi-linear velocity space diffusion is considered for waves of any oscillation branch propagating at an arbitrary angle to a uniform magnetic field in a spatially uniform plasma. The space-averaged distribution function is assumed to change slowly compared to a gyroperiod and characteristic times of the wave motion. Nonlinear mode coupling is neglected. An H-like theorem shows that both resonant and nonresonant quasi-linear diffusion force the particle distributions towards marginal stability. Creation of the marginally stable state in the presence of a sufficiently broad wave spectrum in general involves diffusing particles to infinite energies, and so the marginally stable plateau is not accessible physically, except in special cases. Resonant particles with velocities much larger than typical phase velocities in the excited spectrum are scattered primarily in pitch angle about the magnetic field. Only particles with velocities the order of the phase velocities or less are scattered in energy at a rate comparable with their pitch angle scattering rate. (auth)

9574 ELECTROSTATIC INSTABILITY OF A BOUNDED ION BEAM. Popov, Yu. S. JETP Lett. (USSR) (Engl. Transl.), 4: 238-9(Nov. 1, 1966).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Redaktsiyu, 4: 352-4(Nov. 1, 1966).

The one-dimensional equations for ion beam stability in a bounded plasma are solved for solutions of the form $a(x)\cdot\exp(\omega t)$, where a(x) are the amplitudes of the perturbations. (M.O.W.)

9575 SCATTERING OF ENERGETIC PARTICLES BY LABORATORY PLASMAS. Montgomery, David (Univ. of Iowa, Iowa City); Roque, Celso; Alexeff, Igor. Phys. Fluids, 9: 2500-3(Dec. 1966).

Possible experiments on the scattering of energetic particles by laboratory plasmas are discussed. Expressions for scattering coefficients in terms of the electric field autocorrelation function are derived. Sample situations are considered. Whereas incoherent scattering of electromagnetic waves is governed by the charge density autocorrelation function, energetic particle scattering is governed by the electric field autocorrelation function. (auth)

9576 AERODYNAMIC MEASUREMENTS IN A PLASMA JET. Pinegre, Michel; Larcher, Ghislain; Huet, Pierre; Valentin, Pierre (Univ., Rouen). Compt. Rend., Ser. B, 263: 1167-9(Nov. 21, 1966). (In French).

Some applications of measurements made using a low pressure, high sensitivity, short response time collector, developed at the Faculte des Sciences of Rouen were reported. The distribution of dynamic pressures in a laminar jet of helium heated by an electric arc was determined. (J.S.R.)

9577 TRANSVERSE WAVES IN PLASMA. Varma, N. L. (Univ. of Rajasthan, Jaipur, India). Proc. Nat. Inst. Sci. India, Pt. A, 32: 1-13(Jan. 1966).

Transverse electromagnetic waves have been studied in collisionless, one-component classical plasma using Vlasov's linearized equation and Maxwell's equations and it is also extended to the case when a constant external magnetic field B_0 permeates plasma. The respective characteristic equation is solved by means of Van Kampen's method of stationary solutions following Case closely. The dispersion equation for the cold plasma is obtained from general dispersion equation. (auth)

9578 PLASMA OSCILLATIONS PERPENDICULAR TO A WEAK MAGNETIC FIELD. Baldwin, D. E. (Yale Univ., New Haven); Rowlands, G. Phys. Fluids, 9: 2444-53(Dec. 1966).

The propagation of electrostatic waves perpendicular to a uniform magnetic field, the so-called Bernstein modes, are discussed. It is shown, in the limit as the strength of the magnetic field approaches zero, that these modes, which themselves are undamped, collectively act so as to form a single damped mode identical to the usual Landau damped mode appropriate to zero magnetic field. The behavior of the plasma for small but finite magnetic field is also considered. It is shown that damping due to phase mixing exists for a time short compared to ω_c^{-1}, the reciprocal of the cyclotron frequency. In times long compared to this, the plasma exhibits a quasi-periodic behavior with period $2\pi/\omega_c$. (auth)

9579 HYDROMAGNETIC FREE JET. Wilson, D. H. (Univ. of Durham, Eng.). Phys. Fluids, 9: 2527-8(Dec. 1966).

A two-dimensional jet of conducting fluid issuing from a slot in a wall and acted on by a transverse magnetic field is found to be split into two jets parallel to the wall. (auth)

9580 EFFECT OF TEMPERATURE GRADIENTS IN THERMIONIC PLASMAS. Chen, F. F. (Princeton Univ., N. J.). Phys. Fluids, 9: 2534-5(Dec. 1966). (MATT-472).

Treatments of drift wave velocities in Cs and K plasmas up to now have neglected the radial electric field in the plasma. It is shown that this field greatly affects such measurements, but can be made negligible by reducing the cathode temperature gradient. (auth)

9581 EXTENSION OF THE FOKKER–PLANCK EQUATION. Price, John C. (Univ. of California, Berkeley). Phys. Fluids, 9: 2408-11(Dec. 1966).

A simple collision term valid to order $1/\ln\Lambda$ is derived for small-amplitude waves in a uniform plasma. This result extends the validity of Fokker–Planck type equations from the domain $0 \leq \omega \ll \omega$, $0 \leq k \ll k_d$ to the domain $0 \leq \omega \ll \Lambda\omega_p$, $0 \leq k \gtrsim k_d$ (auth)

9582 CALCULATION OF THE FLOATING POTENTIAL IN A PLASMA CONTAINING NEGATIVE IONS. Klein, Siegfried; Kraus, Pierre (Institut National des Sciences et Techniques Nucleaires, Gif-sur-Yvette, France). Compt. Rend., Ser. B, 263: 1104-7(Nov. 14, 1966). (In French).

Numerous experiments have shown that it is possible to cause the appearance of important electromotive forces in an ionized medium by the creation of an agitation velocity dissymmetry between the negative charge carriers near the two electrodes. It is shown that the variation of the floating potential of such electrodes is a logarithmic function of the attachment coefficient α of the electrons on the neutral particles. (tr-auth)

9583 IONIZATION PHENOMENA IN A GAS-PARTICLE PLASMA. Gibson, Edward G. (Guggenheim Jet Propulsion Center, Pasadena, Calif.). Phys. Fluids, 9: 2389-99(Dec. 1966).

Particles in a plasma can appreciably change the electron density from the value it would assume if the particles were not present. The case of pure particle ionization in which there is only thermionic emission from the particles and no gas ionization, is first considered. It is established that the potential and the charge distributions can be divided into a strong shielding regime, in which most of the free electrons are packed close to the particle surfaces in regions of high potential, and its direct opposite, a weak shielding regime. In both regimes, the free-electron content of the plasma is most readily altered by variations in the particle size, rather than in the work function or particle temperature. The suppression of one form of ionization by the other when both particle and gas contribution to the electron density are comparable is next investigated. In the case of gaseous ionization enhancement it is shown that, if the thermionically emitting particles are hotter

than the gas, the electron temperature will also be higher than that of the gas and the gaseous ionization thereby enhanced. Lastly, it is shown that in some transient situations, the particles are able to control the time rate of change of the electron density. (auth)

9584 EXPERIMENTAL RESULTS ON THE ION-BEAM EXCITATION OF DRIFT WAVES IN AN ALKALI PLASMA. Enriques, L. (Princeton Univ., N. J.). Phys. Fluids, 9: 2493-9 (Dec. 1966). (MATT-408).

An experiment is described in which azimuthal drift waves were excited in the quiescent plasma of a Q machine by means of a modulated low-density ion beam. The characteristics of propagation of a sinusoidal signal and their variations with the velocity of the beam and with the frequency of modulation are described. The signal is found to propagate azimuthally in the direction of the electron drift and axially with phase velocity close to the ion-beam velocity. This is consistent with the predictions of a simplified theoretical model of the ion-beam interaction with a nonuniform plasma. (auth)

9585 STATIC THEORY OF A DISCHARGE COLUMN AT INTERMEDIATE PRESSURES. Self, S. A.; Ewald, H. N. (Stanford Univ., Calif.). Phys. Fluids, 9: 2486-92(Dec. 1966).

A steady-state theory of the discharge column is derived which is applicable in the pressure range where the ion mean free path is neither much greater than nor much less than the column radius, and which goes over in the low- and high-pressure limits to the free-fall and ambipolar diffusion theories, respectively. Solutions for planar and cylindrical geometry are given for the density and potential profiles. The plasma-sheath boundary is discussed and the sheath potential drop is estimated. The theory is shown to agree well with measurements in mercury discharges over the pressure range 1 to 20 μ Hg. (auth)

9586 WAVE PROPAGATION NEAR ELECTRON CYCLOTRON HARMONICS IN NONUNIFORM PLASMAS. Pearson, Gary A. (Bell Telephone Labs., Inc., Murray Hill, N. J.). Phys. Fluids, 9: 2454-63(Dec. 1966).

Equations are derived that describe the excitation and propagation of longitudinal waves (Bernstein modes) in nonuniform plasmas with a uniform applied magnetic field perpendicular to the direction of wave propagation and to the gradients of the unperturbed plasma. Certain features of the microwave absorption by plasma columns have recently been explained on the basis of such modes. Comparison shows that the equations derived by most other authors are correct only when the scale of the plasma inhomogeneity is long compared to the wavelength considered; this is primarily because they ignore the ambipolar electric field and the anisotropy of the unperturbed electron velocity distribution. The inclusion of these effects does not complicate the equations. (auth)

9587 LONGITUDINAL MODES IN MAGNETIZED NONUNIFORM PLASMA COLUMNS. Frisch, H. L.; Pearson, Gary A. (Bell Telephone Labs., Inc., Murray Hill, N. J.). Phys. Fluids, 9: 2464-71(Dec. 1966).

Certain resonant frequencies of magnetized cylindrical plasma columns were calculated using the theory of Buchsbaum and Hasegawa as well as an improved theory that takes into account the ambipolar electric field and the anisotropy of the electron velocity distribution. Attention is restricted to longitudinal modes with no propagation along the column axis and with frequencies near the second harmonic of the electron cyclotron frequency. For azimuthally symmetric modes (and for analogous planar models), the resonant frequencies calculated numerically using these two theories differ little; both theories agree with experiment to within the experimental uncertainties. Modes that are not azimuthally symmetric are described by a fourth-order differential equation that has not been solved exactly. An approximate perturbation theory treatment that was carried out suggests that the true eigenfrequencies are close to those obtained from a much simpler second-order equation. (auth)

9588 MOVING STRIATIONS AND HELICAL OSCILLATION IN A LONGITUDINALLY MAGNETIZED POSITIVE COLUMN. Yatsui, Kiyoshi; Ohji, Takayoshi; Inuishi, Yoshio (Osaka Univ.). Jap. J. Appl. Phys., 6: 105-11(Jan. 1967).

The effect of a longitudinal magnetic field on the characteristics of moving striations appeared in low-pressure gaseous plasma, and the relation between these striations and helical oscillation was experimentally investigated in connection with anomalous diffusion. Although the frequency of striations decreases monotonically with increasing magnetic field, wavelength shows complex changes. It is found that a strong interaction exists between these striations and helical oscillation in the region of anomalous diffusion. Moving striations begin to be strongly damped with distortion of wave forms in the presence of helical oscillation. (auth)

9589 ASYMPTOTIC KINETIC EQUATION FOR INHOMOGENEOUS PLASMAS. Guernsey, R. L. (Univ. of Maryland, College Park). Can. J. Phys., 45: 179-202(Jan. 1967).

The equations for the pair correlation of a slightly inhomogeneous plasma obtained under two different forms of Bogolubov's assumptions are solved and the results are shown to be identical. The results are then compared with the corresponding result for the initial value problem. The contribution of the latter to the kinetic equation is shown to relax slowly ($\sim(\omega_p\tau)^{-\frac{1}{2}}$) to the asymptotic (in the sense of Bogolubov) result. The present result differs from that of Wu and Rosenberg, who appear to have linearized their equations improperly. (auth)

9590 NEUTRALIZATION AND INTERACTION PHENOMENA IN A LOW-DENSITY ION EXHAUST. Sellen, J. M. Jr. (Space Tech. Labs., Redondo Beach, Calif.). pp 305-17 of Physics and Technology of Ion Motors. Marble, Frank E.; Surugue, Jean (eds.). New York, Gordon and Breach Science Publishers, 1966.

The observed interaction phenomena in the low-density plasma beams of the electrostatic thrust engines are discussed. The interaction of the electrons in the plasma with the electric field structure in the column, and the electron–magnetic field interaction are reviewed. Further phenomena which are considered include the electron–atom and electron–ion interactions, and the generation of oscillations in the plasma column at the plasma frequency from the two-electron-stream instability. The use of the plasma stream for plasma-vehicle studies in a "plasma wind tunnel" is described. (auth)

9591 DENSITY-TIME PROFILES FOR AN ELECTRIC PROPULSION UNIT EFFLUX. McNab, I. R.; McNeill, P. C. (Elliott Brothers (London) Ltd., Borehamwood, Eng.). pp 343-56 of Physics and Technology of Ion Motors. Marble, Frank E.; Surugue, Jean (eds.). New York, Gordon and Breach Science Publishers, 1966.

The initial particle densities (n_0) obtained from present electrical propulsion units indicate that, at altitudes between 50 and 200 miles, the decay of density in the efflux may be obtained using a diffusion approach: numerical density–time profiles are given. When $n_0 < 10^{12}$ ions/cm^3 the effects of recombination and ionization are shown to be negligible, the efflux remaining fully ionized. The results are compared with those obtained by Molmud for free molecular flow and the difference between the two approaches is explained. The effects of such highly ionized exhausts on radio communications between space vehicles and ground stations are discussed. (auth)

9592 TARANTULA: 100kV PINCH DISCHARGE APPARATUS FOR STUDYING SHOCK WAVES. Bell, W. R.; Bishop, A. E.; Crawley, H. J.; Edmonds, G. D.; Paul, J. W. M.; Sheffield, J. (United Kingdom Atomic Energy Authority, Abingdon, Eng.). Proc. Inst. Elec. Eng. (London), 113: 2099-2106(Dec. 1966). (CLM-P78).

An experimental apparatus for research on powerful shock waves in a plasma is described. The shock waves are produced by the cylindrical compression of a plasma by the pinch effect. The experiment is performed in a fused-silica discharge tube 1m long by 0.5m bore. An initial axial magnetic field of up to 0.5Wb/m^2 is provided. A low-pressure gas in the tube is preionized by using various capacitor discharge circuits. A high voltage is then applied inductively between the end electrodes of the tube from a low-inductance circuit. This circuit, which stores up to 100kJ at 100kV, is switched by 40 spark gaps and can deliver up to 1MA with a peak of dI/dt of 2.5TA/s. These high currents generate large impulsive forces which, without care, could damage the fragile silica tube. This tube is held in place by silicone rubber which also provides the main insulation. The design and operation of the apparatus are described with particular emphasis on the two major problems encountered: (a) switching the 100-kV circuit and (b) providing insulation and support for the silica tube. (auth)

9593 POWER FLOW FROM A PLASMA HAVING COMPLEX ELECTROACOUSTIC-WAVE IMPEDANCE. Gallawa, Robert L. (Environmental Science Services Administration, Boulder, Colo.). Proc. Inst. Elec. Eng. (London), 113: 1927-33(Dec. 1966).

The complex electroacoustic-wave impedance is examined and is related to power coupling at a plasma-vacuum boundary via the planewave solution of Maxwell's equations. The reactive component of impedance, which is due to the inclusion of a nonzero collision frequency, is found to be important at frequencies less than the plasma frequency, where it contributes a significant amount to power flow. Thus, at those frequencies, serious errors can be introduced by assuming that the electroacoustic power is made up of the powers in the incident and reflected waves only. (auth)

9594 QUASILINEAR TRANSFORMATION OF WAVES IN AN INHOMOGENEOUS PLASMA AND NONLINEAR EFFECTS. Jung-

wirth, K.; Vaclavic, J. (Inst. of Plasma Physics, Czechoslovak Academy of Sciences). JETP Lett. (USSR) (Engl. Transl.), 4: 312-15(Dec. 1, 1966).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Redaktsiyu, 4: 464-8(Dec. 1, 1966).

It was shown earlier that wave transformation in an inhomogeneous plasma may be caused not only by nonlinear effects, but also by quasilinear ones. In such effects, the plateau produced as a result of quasilinear interaction of one group of waves with the particles can be unstable for another group of waves. The energy density for the lf waves in the initial stage of the process was determined from the kinetic equation. (M.O.W.)

9595 STATISTICAL MECHANICAL FOUNDATIONS. Fried, Burton D. (Univ. of California, Los Angeles). pp 49-90 of Plasma Physics in Theory and Application. Kunkel, Wulf B. (ed.). New York, McGraw-Hill Book Co., 1966.

The statistical mechanics for describing a dense plasma is discussed in terms of various aspects of the following: the plasma in equilibrium, kinetic theory, many-body theory (deduction of a kinetic equation from first principles), and properties of the correlationless kinetic equation. (M.O.W.)

9596 INTRODUCTION TO PLASMA PHYSICS. Kunkel, Wulf B. (Univ. of California, Berkeley); Rosenbluth, Marshall N. pp 1-19 of Plasma Physics in Theory and Application. Kunkel, Wulf B. (ed.). New York, McGraw-Hill Book Co., 1966.

The basic properties of plasma physics are discussed. Such topics as quasineutrality, Debye shielding, the plasma parameter, the plasma frequency, orbits, collisions, plasma kinetic theory, the single-fluid approximation, the role of the macroscopic electric field, and magnetohydrodynamics, are discussed. (M.O.W.)

9597 IONIC AND PLASMA PROPULSION FOR SPACE VEHICLES. Knechtli, Ronald C.; Brewer, George R.; Currie, Malcolm R. (Hughes Research Labs., Malibu, Calif.). pp 389-451 of Plasma Physics in Theory and Application. Kunkel, Wulf B. (ed.). New York, McGraw-Hill Book Co., 1966.

A discussion is presented on electrical propulsion for space vehicles that relates the general directions of current efforts to basic problems in plasma physics, ion-beam generation and control, and particle dynamics. (M.O.W.)

9598 OPTICAL RADIATION. Griem, Hans R. (Univ. of Maryland, College Park). pp 277-97 of Plasma Physics in Theory and Application. Kunkel, Wulf B. (ed.). New York, McGraw-Hill Book Co., 1966.

Theoretical discussions are presented for radiation from small volumes, rate processes, stationary states, and radiation from large volumes. (M.O.W.)

9599 WAVES IN LABORATORY PLASMAS. Wharton, Charles B. (General Atomic Div., General Dynamics Corp., San Diego, Calif.); Trivelpiece, Alvin W. pp 233-75 of Plasma Physics in Theory and Application. Kunkel, Wulf B. (ed.). New York, McGraw-Hill Book Co., 1966.

A discussion is presented for the purpose of providing a brief physical picture of the various modes of plasma waves and oscillations that can be expected in laboratory plasmas, and to provide some of the details of the hf response of a plasma to electromagnetic waves, and to describe the related experimental methods of microwave plasma diagnostics. (M.O.W.)

9600 DIFFUSION DUE TO ION–ION COLLISIONS IN A MULTICOMPONENT PLASMA. Bonnevier, Bjoern (Royal Inst. of Tech., Stockholm). Ark. Fys., 33: 255-70(1966).

Diffusion due to ion–ion collisions between different ion species is considered. Special attention is paid to diffusion of impurities in rotating plasmas. It is shown that impurity ions in many cases are centrifuged out to the plasma border. The possibility of using rotating plasmas for isotope separation is discussed. (auth)

9601 OBSERVATION OF THE CRITICAL MAGNETIC FIELD BY LIGHT INTENSITY FROM A POSITIVE COLUMN. Sato, Masumi (Tohoku Univ., Sendai). Appl. Phys. Lett., 10: 11-12 (Jan. 1, 1967).

The light intensity of a positive column in a longitudinal magnetic field changes with the field and becomes minimum at the critical field when a helical oscillation appears in the positive column. As this change is very steep at the critical point, even when the longitudinal electric field does not clearly show the point, an observation of the light intensity of the positive column may be useful in detecting the critical field value. (auth)

9602 OBLIQUE WAVE PROPAGATION IN A COMPRESSIBLE GENERAL MAGNETOPLASMA. Unz, H. (RAND Corp., Santa Monica, Calif.). Appl. Sci. Res., 16: 105-20(1966).

The refractive index equation was derived for arbitrarily directed oblique waves in compressible general magnetoplasma with arbitrarily directed magnetostatic field. The q factor obeys a general sixth-order algebraic equation. Booker's quartic equation and Seshadri's result are found as particular cases and other particular cases are discussed. The general result is checked by using tensor analysis methods and transformation of coordinates. (auth)

9603 GENERATION OF SECOND HARMONIC RADIATION BY A MICROWAVE MAINTAINED PLASMA AT CYCLOTRON RESONANCE. Baughan, K. M. (Univ. of Aston, Birmingham, Eng.); Robson, P. N. Int. J. Electron., 21: 285-301(Sept. 1966).

An experiment is described in which a gas discharge in argon is initiated and maintained within a waveguide by an incident x-band microwave signal. Cyclotron resonance is established between the microwave signal and a superimposed axial magnetic field. Second harmonic power is observed to be radiated from the discharge at K band for a limited range of gas pressure. Theoretical calculations of the expected harmonic output are included and compared with experimental results. (auth)

9604 ARC INITIATION AT METAL SURFACES IN A HYDROGEN PENNING DISCHARGE. Holliday, J. H.; Isaacs, G. G. (Hirst Research Center, Middlesex, Eng.). Brit. J. Appl. Phys., 17: 1575-83(Dec. 1966).

Arc formation at metal surfaces in a hydrogen plasma was studied at gas pressures of 25 to 60 mtorr. The plasma was generated by means of a high current cold cathode Penning-type discharge with axial magnetic field, which defined the electrode areas receiving ion bombardment. Planar cathodes and probe wires of various metals were subjected to 100 μsec pulses respectively, each at about 10A cm^{-2} and 2 kV. The occurrence of arcs was investigated over long periods, up to 10^6 pulses at a rate of one per second. Measurements of time lag to arc formation showed two distinct stages in the conditioning of the metals under ion bombardment. Initially, specimens with contaminated or oxidized surfaces arced at every pulse, with mean time lags increasing from about 2 μsec to the full pulse length over a number of pulses; this number was dependent on the degree of contamination. Finally, when sputtering had removed surface impurities, the few arcs still occurring formed near the start of a pulse and occurred randomly with the number of pulses. The final arcing rate is shown to correlate with the impurity content of the metal. The effects of heat treatment in hydrogen before test and of heating during test were examined. For example, zero arcing rate was obtained over 5×10^5 pulses with high purity platinum maintained at 700°C in hydrogen. Local heating of particles on the surface under ion bombardment is consistent with the initial arcing behavior. Field emission associated with impurities within the metal may account for the arcing behavior after conditioning. (auth)

9605 EXPERIMENTS ON REFLECTED SHOCK WAVES IN PLASMA FLOW: MAGNETIC FIELD INTERACTIONS. Pain, H. J. (Imperial Coll. of Science and Tech., London); Smy, P. R. Brit. J. Appl. Phys., 17: 1585-93(Dec. 1966).

Well-defined stationary and reflected shocks were produced in a moving argon plasma which interacts with a stationary magnetic field. When the interaction region is short, the interaction forces required to produce standing shocks at different flow pressures show good agreement with theory and as the field strength is increased both the speed of the reflected shock and the magnitude of the interaction force closely approach maximum theoretical values. When the interaction region is longer, appreciable slowing of the flow is frequently observed, but this phenomenon is not reproducible. This lack of reproducibility is attributed to the nonattainment of steady-state flow. (auth)

9606 THE POSITIVE COLUMN IN A MAGNETIC FIELD AT LOW PRESSURES: THE TRANSITION FROM FREE-FALL TO AMBIPOLAR CONDITIONS. Forrest, J. R.; Franklin, R. N. (Oxford Univ.). Brit. J. Appl. Phys., 17: 1569-74(Dec. 1966).

The free-fall theory for a positive column in a magnetic field is extended to a more general form applicable over the whole pressure range normally used for arc discharges. The theory is asymptotic in the low-pressure range to that of the Langmuir and Tonks free-fall model, and in the high-pressure range to that of the Schottky ambipolar model. The theory is used to predict, for a number of gases, the transition region where correction to either of the above models becomes necessary, and to evaluate the variation of electron temperature with the similarity variable pressure times discharge radius for mercury. The variation of electron temperature and radial electrostatic field for a plasma column in a magnetic field is also discussed. (auth)

9607 ELECTRICAL CONDUCTIVITY OF A PARTIALLY IONIZED GAS. Schweitzer, Samuel. Stanford, Calif., Stanford Univ., 1966. 214p.

Thesis.

A simplification of the Chapman–Enskog method for a multi-

component partially ionized gas in applied electric and magnetic fields is presented in which the order of the resulting matrix is the same as the order of the approximation and is independent of the number of species. The first three approximations of the parallel electrical conductivity as a function of degree of ionization have been calculated for a three-component gas, taking the electron-neutral collision frequency to be proportional to a power of the relative electron speed. These calculations are compared with several proposed mixture rules. In order to evaluate Frost's proposed mixture rule for engineering applications, the spread in the calculated electrical conductivity resulting from uncertainties in the electron–neutral collision cross sections was examined. Relying on published data, reasonable upper and lower bounds for the electron–argon and electron–cesium elastic scattering cross section have been constructed, and these have been used to estimate the resulting uncertainty in calculated electrical conductivity (using Frost's formula). (TSS)

9608 TWO-DIMENSIONAL, STEADY-STATE SOLUTIONS FOR A PLASMA CROSSING A MAGNETIC FIELD. Poukey, James Wesslen. Madison, Wis., Univ. of Wisconsin, 1966. 105p.

Thesis.

A first step towards the theoretical description of the phenomenon of a plasma blob moving through a transverse external magnetic field is to search for steady-state, two-dimensional solutions in the reference frame moving with the plasma for the case when the external field is uniform. The assumption of two dimensionality means specifically that the total magnetic field is unidirectional and all quantities are unvarying in this direction. The interaction between the plasma and the external magnetic field can be described with the Maxwell–Vlasov set of equations. If the magnetic moment invariant and the corresponding solution to Vlasov's equation are expanded assuming gyroradii to be small compared with distances over which the fields change appreciably and assuming drift velocities to be small compared with gyrational velocities, it can be shown that both the charge density ρ and the magnetic field strength B are constant on lines of constant electrostatic potential. This property of ρ and B can be used to find explicit solutions to the problem of plasma crossing a uniform magnetic field. The essence of the method is to solve the particular form of Poisson's equation resulting from the property of ρ and to use this solution to find the other quantities of interest. Although several analytic solutions of the Poisson equation are possible, in general numerical techniques are required. Finally, time-dependent versions of the steady-state solutions may be obtained for the case where the external magnetic field is slightly nonuniform in the direction of motion of the plasma. The method involves using the adiabatic invariant commonly known as the flux invariant. (Dissertation Abstr.)

9609 MEASUREMENT OF THE SYNCHROTRON RADIATION FROM A HOT ELECTRON PLASMA. Sesnic, Stjepko. Berkeley, Calif., Univ. of California, 1966. 189p.

Thesis.

A far infrared spectrometer is constructed to measure the synchrotron radiation from a hot electron plasma in the wavelength range between 0.1 and 4 mm. The synchrotron radiation (4.0 to 0.2 mm wavelength) emitted from a hot electron plasma in a strong magnetic field is studied experimentally. The measurements are made with a 1 μs time constant InSb detector with a frequency response covering the wavelengths between 4.0 and 0.1 mm. For peak fields which are varied between 25 kG and 60 kG with corresponding electron temperatures between 35 and 80 keV the radiation in perpendicular direction is found to increase with ~3.8 power of the magnetic field. This variation is consistent with that calculated by integrating the radiation from a single electron over a two-dimensional, relativistic Maxwellian with the appropriate temperature. Both from the measurement of the total radiated power and from the results of the spectral distribution measurements the total number of radiating electrons are determined to be of the order 10^{11}. The variation of the total parallel radiation with magnetic field is not consistent with the theory but assuming mode cut off conditions in the detector light pipe system the theory seems to agree with the experimental results. The absolute spectral distribution of the radiation in both perpendicular and parallel directions is measured and agrees with the theory of Trubnikov except for some additional structure. A possible explanation for this structure is given. (TSS)

9610 PLASMA PHYSICS IN THEORY AND APPLICATION. Kunkel, Wulf B. (ed.). New York, McGraw-Hill Book Co., 1966. 508p. $15.50.

Separate abstracts were prepared for the 13 included chapters. (M.O.W.)

For abstracts of individual chapters see: 9367, 9391, 9392, 9535–9537, 9595–9599, 9618, and 9634.

9611 SOLUTION OF THE BOLTZMANN'S EQUATION FOR THE ELECTRICAL CONDUCTIVITY OF A SLIGHTLY IONIZED GAS (IN THE PRESENCE OF A WEAK MAGNETIC FIELD). Smith, Gerald Lynn. Norman, Okla., Univ. of Oklahoma, 1966. 117p.

Thesis.

To treat a gas experiencing ionization as the natural interaction of its constituent particles requires a statistical model built on a probability distribution function. The function most commonly felt to produce the best mathematical model is the Maxwell's phase-space distribution function. This function is used to describe the probable energy distribution of the gas particles. Since the number density of particles is generally a function of geometry, velocity, and time, the rate of change of the distribution with respect to time is expressible in terms of partial derivatives. This partial differential equation is the Boltzmann's equation; inclusion of the Maxwell's distribution generates the well-known Maxwell–Boltzmann transport equation. The solution of the Maxwell–Boltzmann equation is accepted to be impossible to achieve in a direct and general sense. Several techniques have been developed to formulate an approximate solution, but these have not proven to be accurate in light of experimental tests. An approximate solution to the Maxwell–Boltzmann equation is presented which does not require the cross product terms be neglected. Three ordinary, linear differential equations are generated, the solution of which will allow electrical conductivity to be calculated. Although the formulation is derived in an entirely general sense, a numerical solution of the differential equations offers the best results, when a specific experimental model is of interest. (TSS)

9612 ELECTRONIC PROPERTIES OF THE PENNING DISCHARGE PLASMA. Kerr, Donald MacLean Jr. Ithaca, N. Y., Cornell Univ., 1966. 190p.

Thesis.

Plasmas produced in a Penning discharge have been studied theoretically and experimentally for possible use as an active electronic medium in high-frequency amplifiers, oscillators, or noise generators. The work has been particularly directed toward understanding the mechanism of particle transport across the magnetic field and the associated instabilities. Measurement techniques include microwave scattering, Langmuir probe, and particle energy analysis; typical operating conditions were: $n_e = 10^{10}$ to $10^{12}/cm^3$, $T_e = 2$ to 5 eV, discharge current 100 to 500 mA, magnetic field strength 100 to 500 gauss, and pressure 10^{-4} to 10^{-12} torr in Ar, N_2 and H_2. Density profiles, radial diffusion, and electron energy distributions were measured. The last was non-Maxwellian with two distinct peaks. Oscillations of 4 to 5 kc and over one volt peak-to-peak were associated with increased radial diffusion. Their frequency and amplitude depended on the gas, magnetic field, pressure, and discharge current. Phase differences between signals received on probes as various positions in the plasma indicated that the oscillations were caused by rotating, spiral density perturbations, similar to the screw instability in the positive column. Nonpropagating ion oscillations, excited by the anisotropic electron velocity distribution, were found from 300 to 500 kc only in Ar discharges. The maximum amplitude occurred at the column edge. As the magnetic field increased the frequency increased and the amplitude decreased. Between the electron cyclotron and electron plasma frequencies noise was detected, with broad peaks at the cyclotron frequency and its harmonics. Theoretical calculations relating the lower frequency oscillations to the measured diffusion rate are presented. The consequences of the non-Maxwellian velocity distributions are discussed and considerable data are presented for both steady state and oscillatory phenomena. (Dissertation Abstr.)

Production of Plasma

Refer also to abstract 9537.

9613 (NP–16419) ANNUAL PROGRESS REPORT, 1966. (Toronto Univ. (Ontario). Inst. for Aerospace Studies). Oct. 1966. 254p. Dep. mn.

The theoretical work on the free-molecular transport properties associated with the internal flow through axisymmetric tubes is continuing by using wall reflection laws that are more general than that of purely diffuse reflection, which was used in all previous calculations at UTIAS. The experimental work in the low density wind tunnel has emphasized the study of the basic gas-dynamic flow problems of free jets and shock structure by means of the electron-beam probe. Two important studies have been completed. The behavior of the rotational degree of freedom in nitrogen free jets and shock waves was found to show appreciable nonequilibrium effects and the observed experimental results on the diffusive separation in helium–argon jet expan-

sions agreed very well with available theory. The diffusive separation in shock waves and near aerodynamic obstacles is now under study. Initial experimental work on the separation in shock compression were obtained and the present effort is directed to experiments in which the shock configuration is amenable to analysis. A theoretical study of shock structure in binary mixtures is under way, which is part of a larger overall program on shock structure in multicomponent gases and plasmas. (auth)

9614 EFFICIENT UTILIZATION OF AN RF POWER OSCILLATOR FOR PRODUCING LOW-PRESSURE PLASMAS. Kofoid, Melvin J. (Boeing Scientific Research Labs., Seattle). Int. J. Electron., 21: 381-92(Oct. 1966).

In an ordinary arrangement for high-frequency plasma heating a discharge tube is placed inside an rf coil, as in the analogous case of the induction heating of metals, and the coil is connected to a standard power oscillator. If a low-pressure plasma is to be produced, i.e., in gas at 0.1 to 500 microns pressure, the energy transferred to the plasma then will be only a small fraction of the generator capacity, because of the low power factor of the load. Simple expedients are described which result in the attainment of a much increased rf magnetic flux density in the discharge tube. The resulting increase in the plasma conductivity, hence in the load power factor, is sufficient to effect high and efficient loading. The discussion centers around the use of a 15-kW, 450-kc oscillator for plasma research studies. The usefulness of the generator is considerably increased by electronic control, which allows times of operation as brief as 0.05 sec. Short-time operation and low average loading permit the exceeding of normal oscillator current limits to obtain high rf fields for starting and maintaining low-pressure plasmas—extending the possible range of operation. Comprehensive performance data are presented. (auth)

9615 PERTURBATION OF A MAGNETIC FIELD BY THE PLASMA OF A LASER SPARK IN AIR. Savchenko, M. M.; Stepanov, V. K. (Lebedev Inst. of Physics, Moscow). Zh. Eksp. Teor. Fiz., 51: 1654-9(Dec. 1966). (In Russian).

Results of a detailed investigation of diamagnetic perturbation of an external magnetic field by the plasma of a laser spark in air are presented. It is shown that the dimensions of the region which disturb the field are small compared to the dimensions of the luminous region. The perturbation is long-lived, with a lifetime of 30 to 40 μsec; however the shock wave reflected from obstacles near the spark reduces the lifetime and leads to transformation of the diamagnetic perturbation into a paramagnetic one. (auth)

9616 PRECURSOR PHENOMENA OF SHOCK WAVES IN ARGON. Valentin, Pierre; Leboucher, Jean-Claude (Commissariat a l'Energie Atomique, Paris). Compt. Rend., Ser. B, 263: 959-62(Oct. 24, 1966). (In French).

The electron density profile before a shock in argon was evaluated and the ultraviolet brilliance of the plasma behind the shock wave was estimated. (tr-auth)

9617 REFLEX DISCHARGE IN ARGON USING BRUSH CATHODES. Allison, J.; Chambers, B. (Univ. of Sheffield, Eng.). Electron. Lett., 2: 443-4(Dec. 1966).

A useful laboratory plasma has been produced with a brush-cathode reflex discharge in argon. Plasma measurements made on the discharge indicate that electron densities of 10^{11} cm^{-3} may readily be obtained. The effect of an axial magnetic field on the discharge is also mentioned. (auth)

9618 LABORATORY PLASMA PRODUCTION. Kunkel, Wulf B. (Univ. of California, Berkeley). pp 299-345 of Plasma Physics in Theory and Application. Kunkel, Wulf B. (ed.). New York, McGraw-Hill Book Co., 1966.

Some of the properties of real plasmas are discussed, with emphasis on the methods of production of ionized gases in the laboratory. Brief descriptions are given of the most important or most basic types of laboratory plasmas. (M.O.W.)

Stability of Plasma

9619 (CEA-R-3074) ETUDE DES MICROINSTABILITIES LIEES A L'ANISOTROPIE DE LA FONCTION DE DISTRIBUTION DES VITESSES DES PARTICULES D'UN PLASMA HOMOGENE. (Study of Microinstabilities Due to an Anisotropic Velocity Distribution Function of the Particles of a Homogeneous Plasma). Hennion, Francois (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). Sept. 1966. 75p. (In French). (EUR-3002.f). Dep. mn.

A study is made of instabilities in a plasma with an ion velocity distribution function of the form

$$f_{oi} = -\frac{1}{2\pi\alpha_{\perp_i}\alpha_{\parallel_i}}\,\delta(v_\perp - \alpha_{\perp_i})\,e^{-(v_\parallel^2/\alpha_{\parallel_i}^2)}$$

The plasma is assumed to have finite dimensions limited by infinitely conductive boundary surfaces. A theoretical and numerical analysis of marginal stability locates the regions of stability as a function of several parameters; i.e., plasma length, ion anisotropy (τ) and electron temperature (T_e). A limiting plasma length is found, below which the plasma is stable regardless of its density. For the parameters of the injection experiment M. M. I. I. at Fontenay-aux-Roses, it is found that the type of instabilities studied here should not occur. (auth)

9620 ROTATING PLASMAS. Pfleiderer, J. (Univ., Bonn). Beitr. Plasmaphys., 6: 275-9(1966). (In German).

The equations representing the equilibrium configuration of rotating plasmas are derived. The particular cases of the linear pinch and the plasma torus are considered. (J.S.R.)

9621 TWO-BEAM INSTABILITY. PART II. THE TURBULENT REGIME. Kennedy, W. T. (Queen's Univ., Belfast). Int. J. Electron., 21: 353-66(Oct. 1966).

At critical values of current and voltage, two independent interpenetrating electron beams, or a single incident and reflected beam, can stimulate a multiplicity of high (electron) and low (ion) frequency modes in a low-pressure plasma, together with bright visual effects, in a kind of explosion (bursting) which increases with increase in beam voltage, although not indefinitely. Typical discharge parameters are: beam radius before bursting 0.1 cm; critical voltage 35 V; beam current 15 mA; pressure for discharge in mercury vapor, 1.5 microns. Bursting corresponds to a situation in which linear perturbation theory can no longer be applied. Evidence from probe studies, confirmed in part spectroscopically, is described which shows that the system is in a turbulent state in which its properties can be at least partly described by a computerized model for large-amplitude disturbances. The existence of a positive potential well, with associated trapping of some electrons, has been confirmed. (auth)

9622 STABILITY OF THE THETA-PINCH. Haas, F. A.; Wesson, J. A. (United Kingdom Atomic Energy Authority, Culham, Abingdon, Eng.). Phys. Fluids, 9: 2472-7(Dec. 1966).

A model of a $\beta = 1$ axisymmetric plasma in which the equilibrium quantities are assumed to vary slowly in the axial direction is set up. The energy principle is used to investigate stability, and it is shown that the theta-pinch configuration is stable to the m = 1 mode. (auth)

9623 ON MODES OF A PIG DISCHARGE. Tanaka, Yuji; Yamamoto, Kenzo (Univ. of Nagoya, Japan). Jap. J. Appl. Phys., 5: 1240-5(Dec. 1966).

Experiments were carried out to study the oscillation phenomena in a hot cathode PIG discharge tube which has been used extensively for a high density plasma source. There are four modes of PIG discharge. In the low frequency oscillation mode, a cycloidal motion of electrons at the sheath in front of the cylindrical anode excites a coherent oscillation on the central plasma column whose diameter is equal to that of the hot cathode. This mode of PIG discharge is characterized by the appearance of the magnetron cut-off field above which the oscillation occurs. Other three modes are briefly discussed in connection with this mode. (auth)

9624 KINETIC EQUATION FOR AN UNSTABLE PLASMA IN PARALLEL ELECTRIC AND MAGNETIC FIELDS. Fried, Burton D.; Ossakow, Sidney L. (Univ. of California, Los Angeles). Phys. Fluids, 9: 2428-35(Dec. 1966).

The response of a homogeneous plasma, in a strong uniform magnetic field, B_0, to the sudden application of a strong, uniform electric field is studied in a self-consistent formulation which treats the coupled equations for the one-particle and two-particle distribution functions resulting from neglect of three-particle correlations. As in earlier work on the case $B_0 = 0$, the electric field is assumed to be large compared to that which produces a "runaway current," so that particle–wave interactions should dominate. In the limit of strong magnetic field, use of the Bernstein–Kulsrud expansion in $k_\perp R_{ic}$ makes the problem effectively one-dimensional, eliminating the need for factorization assumptions of the form $f(v) = f_{\parallel}(v_\parallel) f_\perp(v_\perp)$ used in the $B_0 = 0$ case. Only the dominant contributions to the diffusion in velocity space, arising from the fastest growing waves, are retained. Other simplifications result from the assumption of unequal electron and ion temperatures, but it proves necessary to specify the ratio T_e/T_i, rather than simply assuming it to be large. In sharp contrast to the case $B_0 = 0$, it is found that the diffusion affects only those electrons which have, in the ion rest frame, velocities of order $(m/M)^{1/3}$ of the electron thermal speed. No appreciable "quasi-linear" effects, such as the current limitation found in the $B_0 = 0$ case, and therefore to be expected; the results of numerical calculations confirming this are summarized. (auth)

9625 STREAMING INSTABILITIES IN PLASMAS WITH ZERO-ORDER DENSITY GRADIENTS. Lee, Kai Fong (Cornell Univ., Ithaca, N. Y.). Phys. Fluids, 9: 2435-43(Dec. 1966).

Current-carrying plasmas with zero-order density gradients are analyzed for instability using the Vlasov and Maxwell's equations. The plasmas are confined by a strong axial magnetic field, and the densities are nonuniform in the transverse directions. By means of a variational method, it has been found that the density inhomogeneity (1) decreases the real frequency of oscillation, (2) reduces the maximum unstable wave number, and (3) increases the minimum current required for instability and imposes an upper limit on the streaming velocity beyond which the plasma is stable against perturbations of all wavelengths. Explicit results are given for Gaussian and exponential density profiles with resonant, Maxwellian, and delta function velocity distributions. The physical mechanisms that are responsible for these changes are discussed. (auth)

9626 HELICAL INSTABILITY IN A PENNING DISCHARGE. Kerr, Donald M. Jr. (Cornell Univ., Ithaca, N. Y.). Phys. Fluids, 9: 2531-3(Dec. 1966).

Rotating helical perturbations in a Penning discharge were found to accompany low-frequency oscillations and enhanced particle transport across the magnetic field for a wide range of discharge parameters. (auth)

9627 POSSIBILITY OF EXCITATION OF THE KELVIN–HELMHOLTZ INSTABILITY IN ROTATING PLASMAS. Oester, Flemming (Atomic Energy Commission Research Establishment, Riso, Denmark). Phys. Fluids, 9: 2529-31(Dec. 1966).

A discussion of the possibility of excitation of the Kelvin–Helmholtz instability in a rotating plasma is given. It is found that this type of instability does not seem to occur. The effect of viscosity is not taken into account. (auth)

9628 EXTENSION OF THE NEWCOMB ENTROPY METHOD OF STABILITY ANALYSIS. Rowlands, G. (United Kingdom Atomic Energy Authority, Culham, Abingdon, Eng.). Phys. Fluids, 9: 2528-9(Dec. 1966).

It is shown that a plasma in zero magnetic field whose distribution function is any function of the kinetic energy is stable to longitudinal and transverse disturbances. (auth)

9629 KINETIC INSTABILITY OF A PLASMA LOCATED IN A STRONG HIGH FREQUENCY FIELD. Silin, V. P. (Lebedev Inst. of Physics, Moscow). Zh. Eksp. Teor. Fiz., 51: 1842-51 (Dec. 1966). (In Russian).

It is demonstrated that due to the Cherenkov effect, instability with respect to buildup of potential oscillations is possible in a plasma located in a high frequency electric field. Such a kinetic instability, in contrast to the hydrodynamic instability previously discussed, should also be possible in a plasma in which the electron Langmuir frequency is smaller than the external field frequency. (auth)

9630 NONLINEAR THEORY OF CURRENT INSTABILITY IN A NON-ISOTHERMAL PLASMA. Kovrizhnykh, L. M. Zh. Eksp. Teor. Fiz., 51: 1795-1810(Dec. 1966). (In Russian).

An analytical solution of the nonlinear problem of current instability in a nonisothermal plasma located in an external electric field is obtained within the framework of the theory in which pair collisions and particle scattering on ion-sound noise are taken into account. The shape of the quasistationary noise spectrum is found, and it is shown that if electron scattering on ion sound is taken into account an anomalously high resistance appears which restricts the electron current and prevents the appearance of runaway electrons. Equations are derived for the time variation of the mean electron and ion kinetic energies in the plasma. According to the equations the presence of ion absorption leads to intense heating of the plasma ion component, the velocity being proportional to the external electric field strength. (auth)

9631 PLASMA INSTABILITY ON TRAPPED PARTICLES IN A TOROIDAL GEOMETRY. Kadomtsev, B. B.; Pogutse, O. P. Zh. Eksp. Teor. Fiz., 51: 1734-46(Dec. 1966). (In Russian).

It is demonstrated that in toroidal discharges with a longitudinal magnetic field, an instability may develop which is similar to flute instability of a plasma in the traps with magnetic mirrors. The instability develops on particles trapped between the mirrors, that is, between regions with higher magnetic field strengths. (auth)

9632 TWO-BEAM INSTABILITY. PART I. ONSET OF INSTABILITY. Kennedy, W. T. (Queen's Univ., Belfast). Int. J. Electron., 21: 229-39(Sept. 1966).

Extensive studies were made of instability in two counter-streaming low-voltage electron beams in a low-pressure plasma. Estimates from dispersion theory of the critical conditions at which oscillations should begin were found to agree with experiment. The study of the advanced stages of instability, which are associated with ion and electron oscillations, indicates that a transition has then occurred to turbulence, using this term in a generalized sense. (auth)

9633 TRANSITION FROM A MOVING STRIATION TO A HELICAL OSCILLATION IN A POSITIVE COLUMN. Sato, Masumi; Hatta, Yoshisuke (Tohoku Univ., Sendai). Appl. Phys. Lett., 9: 423-4(Dec. 15, 1966).

A transition from a moving striation to a helical oscillation was observed in the positive column of a helium discharge at a press sure of 0.4 mm Hg as an applied longitudinal magnetic field was increased. The frequency and amplitude of the moving striation decreased with increasing magnetic field. When the magnetic field reached a critical value of about 1650 G, a helical oscillation appeared and the two waves were observed to coexist. The striation disappeared with a further increase of the field, but the helical oscillation continued to exist. (auth)

9634 PLASMA STABILITY. Rostoker, Norman (General Atomic Div., General Dynamics Corp., San Diego, Calif.). pp 119-46 of Plasma Physics in Theory and Application. Kunkel, Wulf B. (ed.). New York, McGraw-Hill Book Co., 1966.

The plasma stability in various magnetic field configurations is discussed. The plasma equations, low-frequency instabilities, θ pinches, microinstabilities, and resistive instabilities are described. (M.O.W.)

9635 WAVE MOTION AND STABILITY OF MAGNETO-PLASMAS HAVING IMPERFECT BOUNDARIES. Fang, Gautier Tien-Ni. Minneapolis, Univ. of Minnesota, 1966. 202p. Thesis.

General normal-mode methods and variational principles are developed, which can be used to investigate the influence of imperfect boundaries on the linear wave motion, diffusion, and stability of magnetoplasma and a wide variety of electromagnetic, acoustic, elastic, thermal, and chemical systems. (TSS)

Thermonuclear Processes

Refer also to abstract 9537.

9636 (UCID–4480) TRITIUM REGENERATION IN A D-T THERMONUCLEAR REACTOR BLANKET. Myers, W. B.; Wells, W. M.; Canfield, E. H. (California Univ., Livermore. Lawrence Radiation Lab.). May 22, 1962. Contract W-7405-eng-48. 19p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Several candidate lithiated materials for a D–T thermonuclear reactor blanket are discussed. The favorable tritium regeneration potential for several fused salts and the liquid metal is presented. (auth)

Shielding

Refer also to abstract 10152.

9637 (AD–643837) CALCULATIONS OF ENERGY LOSS, RANGE, PATHLENGTH, STRAGGLING, MULTIPLE SCATTERING, AND THE PROBABILITY OF INELASTIC NUCLEAR COLLISIONS FOR 0.1- TO 1000-MeV PROTONS. Technical Report, September 1, 1964–May 1, 1966. Janni, Joseph F. (Air Force Weapons Lab., Kirtland AFB, N. Mex.). May 27, 1966. 446p. (AFWL-TR-65-150). CFSTI $3.00 cy, $0.65 mn.

Theoretical calculations were made of the mean energy loss, pathlength, range, multiple scattering, and pathlength straggling of protons in 74 materials, including materials regularly used in radiation shielding and dosimetry. Emphasis was placed on obtaining accurate results, especially for heavy materials and protons of very low energy. Values of the energy loss between 0.1 and 1.0 MeV were obtained by smoothing and interpolating experimental information. Above 1.0 MeV, the Bethe equation with all the necessary shell corrections was used. The polarization effect was calculated in detail for each material. Ranges were obtained from the pathlengths by use of detailed multiple Coulomb scattering theory. Comprehensive tabulations of the range straggling and multiple scattering are presented for each of the materials. The energy loss and range calculations are compared with the available experimental data and the mean deviation is usually within 1.0%. Deviation rarely exceeds the estimated error of the experimental data. The theoretical approach is also discussed in detail, and the method used to obtain the K, L, M, N, and O shell corrections is presented. A first-order correction was made which compensates for the molecular binding effects occurring in compounds. The probability that a proton will undergo an inelastic nuclear interaction throughout its entire pathlength is also tabulated. (auth)

9638 (ORNL–3926) MONTE CARLO CALCULATIONS OF THE PENETRATION OF NORMALLY INCIDENT NEUTRON BEAMS THROUGH CONCRETE. Clark, F. H.; Betz, N. A.; Brown, J. (Oak Ridge National Lab., Tenn.). Jan. 1967. Contract W-7405-eng-26. 17p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The O5R Monte Carlo code has been adapted to calculate fast-neutron doses within and outside of concrete slab shields. Such calculations were performed for a variety of shield thicknesses (0 to 180 cm) and for various monoenergetic sources from 0.7 to 14 MeV. The concrete chosen is ordinary concrete with approximately 6% water content. Results are plotted as tissue kerma versus penetration distance for each source energy. The source is in each case a broad normally incident beam. (auth)

9639 (ORNL–4009) RESULTS OF THE ANALYSIS BY MONTE CARLO OF FAST-NEUTRON SHIELDING PROPERTIES OF COMPOUND CUBICAL AND SPHERICAL SHIELDS. Clark, F. H.; Betz, N. A. (Oak Ridge National Lab., Tenn.). Sept. 1966. Contract W-7405-eng-26. 55p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

An extensive program of calculations was performed to check certain fast-neutron dose-rate measurements made at Project BREN in 1962. The response characteristic of the modified long counter was computed. Nitrogen and oxygen cross sections were reviewed and used in calculations of the transport in air of neutrons from a Godiva source to a distance of 66 g/cm^2. Transport results obtained by Monte Carlo were compared with those obtained by the moments method. A spectrum at an 80-g/cm^2 penetration was determined. The perturbating effect of a structure on the neutron field in its neighborhood was estimated. The effect of variations of the spectrum with penetration distances on doses computed with different weight functions was also examined; the Snyder–Neufeld multicollision physical dose was found to vary with distance in a way markedly different from others examined. Work was also done on importance sampling techniques, especially the exponential transform, and the sampling problem was formulated in a simplified, approximate expression to facilitate statistical interpretations. Finally, a number of shield penetration calculations were performed to compare with the measurements and to determine the effects of shield shape, shield cavity size, and source angular distributions incident on the shields. The agreement between the calculations and the measurements was within the uncertainty in the detector response characteristic. (auth)

9640 SHIELDING TECHNIQUES. Keller, J. Warren. (National Aeronautics and Space Administration, Washington, D. C.). pp 846-64 of Radiation Trapped in the Earth's Magnetic Field. McCormac, Billy M. (ed.). New York, Gordon and Breach Science Publishers, 1966.

The physics of the interaction of charged particles with matter is reviewed, and the techniques currently used for calculating the penetration of such particles through shields are described. A portion of the data currently being generated to assist in shielding calculations is discussed. (J.H.M.)

9641 SOME NEW METHODS FOR SPACE SHIELDING CALCULATIONS. Lowen, R. W.; Sowle, D. H. (General Dynamics/Convair, San Diego, Calif.). pp 875-86 of Radiation Trapped in the Earth's Magnetic Field. McCormac, Billy M. (ed.). New York, Gordon and Breach Science Publishers, 1966.

Some new, simple methods of limited but quite useful accuracy for use in space shielding calculations are described. The energy dissipation by protons isotropically incident on a plane slab is solved analytically. Energy and angular distributions of the bremsstrahlung emitted by electrons incident either normally or isotropically on thick targets are calculated using a semiclassical cross-section and electron distributions for an infinite medium. The results are compared with experiment and with calculations by Berger. The energy dissipation of electrons from a plane perpendicular source is calculated by an age equation model and compared with the accurate calculations of Spencer. (auth)

9642 DOSE BUILDUP FACTORS OF MULTI-LAYER SLABS FOR A POINT ISOTROPIC SOURCE. Miyasaka, Shun-ichi; Tsuruo, Akira (Japan Atomic Energy Research Inst., Tokyo). J. Nucl. Sci. Technol. (Tokyo), 3: 393-400(Sept. 1966).

Dose buildup factors for multi-layer slabs composed of lead and graphite were obtained experimentally for a point isotropic source of ^{60}Co and ^{137}Cs; expressions for these factors are developed. The experimental results are compared with those calculated by the Monte Carlo method, and show a good agreement. The buildup factors for the second material behind the first increase, or decrease, very markedly for heavy-light, and light-heavy, layers. From these experimental results, it would be possible to assume that the dose buildup factor for the second material of a double layer slab is composed of two parts, namely asymptotic and transient. The transient part is that which increases or decreases very rapidly within about 1 mean free path from the interface of the first and second layers. The asymptotic part increases proportionally with the buildup factor for the second material. The rise or fall of the buildup factor in the second material can be explained from the change of the spectra in the second material. The experimental results are also compared with those calculated by Kalos' formulas and that of Broder. Broder's buildup factors are very different from the experimental results. (auth)

9643 THE DIFFUSION OF WATER IN CONCRETE AT TEMPERATURES BETWEEN 50 AND 95 DEG C. Hughes, B. P.; Lowe, I. R. G.; Walker, J. (Univ. of Birmingham, Eng.). Brit. J. Appl. Phys., 17: 1545-52(Dec. 1966).

The water content of concrete used in nuclear reactor shields plays an important part in settling the shielding characteristics, and the movement of water is largely responsible for the long-term behavior of the shields. The prediction of the long-term behavior is clearly desirable. Drying tests were made on concrete and neat cement spheres of various diameters and it is indicated that elementary diffusion theory is useful for the temperatures investigated (between 50 and 95°C). The diffusion coefficient is, however, strongly dependent on temperature. Surface drying mechanisms are considered and it is shown that they can retard the moisture diffusion process in normal applications. (auth)

9644 NEUTRON ATTENUATION BY STEEL EMBEDDED CONCRETE. Hirai, Kiyoshi (Fuji Electric Mfg. Co., Ltd., Japan). Fuji Jiho, 39: 773-7(Nov. 1966). (In Japanese).

Steel pipes are to be embedded in a concrete wall near the core of the Concrete Pressure Vessel Reactor for cooling purposes and it is necessary to know neutron distributions in the wall to estimate the heat generated by captured γ rays. Calculations were made for the following: equivalent weight of iron embedded as a steel plate, equivalent weight of iron distributed uniformly in concrete, and ordinary concrete not containing any additional iron. The experiments were done in the Bulk Shielding Facility (water pool) attached to the 100 kW TRIGA MARK II Reactor. Four concrete samples, one in which steel pipes were embedded and three corresponding to the cases above, were prepared and neutrons before and behind these samples were measured. Detectors used were Au foils and BF_3 counters for thermal neutrons and sulfur for fast neutrons. Results are compared with two-group calculations for each corresponding sample and comments are given on practical application of the results. (auth)

9645 APPLICATION OF INVARIANT IMBEDDING TO THE REFLECTION AND TRANSMISSION PROBLEMS OF GAMMA RAYS. II. Shimizu, Akinao; Mizuta, Hiroshi (Nippon Atomic Industry Group Co., Kawasaki, Japan). J. Nucl. Sci. Technol. (Tokyo), 3: 441-7(Oct. 1966).

The transmission of γ rays through a slab was calculated by the method of invariant imbedding. The results are in good agreement with other reliable solutions obtained by the moments method and Monte Carlo calculations. The present method has the following advantage: (1) It permits determination of the energy and angular distributions of reflected or transmitted photons due to monoenergetic and monodirectional source photon; (2) the method can be applied to multilayer slabs; (3) extension to thicker slabs can be easily made; (4) the execution time required for numerical solutions is short enough to permit systematic calculations for many elements. (auth)

Solid-State Physics

9646 (NP–16439) NEITRONOGRAFICHESKIE ISSLEDOVANIYA NIZKOTEMPERATURNOGO MAGNITNOGO PREVRASHCHENIYA V KHROME. (Neutronographic Investigation of Low-Temperature Magnetic Transition in Chromium). Report No. 393. Alikhanov, R. A.; Smirnov, L. S. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Moscow. Institut Teoreticheskoi i Eksperimental'noi Fiziki). 1965. 16p. (In Russian). Dep. mn.

Neutronographic investigations of low-temperature magnetic transition were performed on polycrystallic chromium samples with an equal content of admixtures but with different thermomechanical treatment and on monocrystal samples using a miniature cryostat of original construction (530 g weight, 200 mm height). The rise of transition temperature with the metal plasticity increase was found. It was shown that the period of modulation spin density wave and its temperature dependence are the universal property of chromium. (auth)

9647 (NYO–2391-41) EXPERIMENTAL PHONON PHYSICS. Progress Report, April 1, 1966–March 31, 1967. Pohl, R. O.; Krumhansl, J. A.; Sievers, A. J.; Taylor, A. (Cornell Univ., Ithaca, N. Y. Lab. of Atomic and Solid State Physics). Dec. 1966. Contract AT(30-1)-2391. 14p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Measurements were continued of thermal and infrared properties of solids in studies of impurity modes (effects of lattice defects on vibrational spectrum of solids). The results reported

include: phonon scattering by tunneling states in KCl:Li, hindered rotation of CN^- in RbCl, test of model for superconducting metals, absence of electric field-induced dichroism of near ir stretching vibration of CN^--doped crystals, search for second sound in pure alkali halide crystals, and development of a doped germanium far ir detector. Other studies are also reported on briefly. A short account is given of the development of the 3.0-MeV Dynamitron. (D.L.C.)

9648 EXPERIMENTAL INVESTIGATION OF CONDUCTIVITY INDUCED BY ELECTRON BOMBARDMENT AND APPLICATION TO MEMORY TUBES. Guillard, C. (CSF Compagnie Generale de Telegraphie Sans Fil, Orsay, France). Ann. Radioelec., 21: 195-210(July 1966). (In French).

A study of this phenomenon was conducted to explore its possible applications to image tubes. The investigation included 2 main parts: first, examination of the charge of an insulator by means of a scanning beam of fast (>1-MeV) electrons; second, examination of the effect of various parameters which play a part in induced conductivity. The results led to the expression of a law which relates the gain of induced conductivity to the relevant factors. The validity of the results was verified in a number of applications, including those using a standard transformation tube, television camera tube, and an electron microscope. The results make possible the calculation of the number of charges generated by induced conductivity, and appearing on the free surface of the insulator, and determination of the time required by the scanning beam to bring the insulator potential from a value V to a value $V + \Delta V$. In the study of the effect of various parameters which play a part in induced conductivity, the influence of the thickness of the insulator, the electric field within the insulating layer, and the energy of the bombarding electrons was examined. The results obtained apply essentially to layers of ZnS, obtained by vacuum evaporation. (BBB)

9649 RECOMBINATION RADIATION OF ZnS SINGLE CRYSTALS EXCITED BY FAST ELECTRONS. Bogdankevich, O. V.; Zverev, M. M.; Pechenov, A. N.; Sysoev, L. A. (Lebedev Inst. of Physics, Moscow). Fiz. Tverd. Tela, 8: 2547-8(1966). (In Russian).

Laser action was reported in electron-beam-pumped ZnS single crystals with a large forbidden gap. High-purity hexagonal ZnS specimens were soldered with indium to a copper heat sink kept at liquid N temperature (except in the case of some experiments conducted at room temperature). The electron beam was focused on the polished surface of the specimen at right angles to the two polished ends. The emission recorded by a ZMR-3 monochromator and an FEU-18A photomultiplier was observed in the direction perpendicular to the incident beam. Recombination radiation was observed in the ultraviolet region when ZnS was excited by a pulsed beam of 50-kv electrons at current densities up to 6 amp $\cdot$ cm^{-2}. At increased current densities (6 amp $\cdot$ cm^{-2} and up) and 80K, emission of a line (14 Å wide) at 3300 Å was predominant. The shapes of the light and current pulses were coincident, which would seem to indicate that the lifetime of nonequilibrium carriers did not exceed 10^{-7} sec. A 3-Å displacement in the intensity maximum of the 3300-Å line in the long-wave direction was observed at increased current densities and was attributed to the overheating of specimens. (ATD)

9650 ON THE MECHANISM OF RADIATION COLORING OF NaCl MONOCRYSTALS. Elango, M. A. Zh. Prikl. Spektrosk. Akad. Nauk BSSR, 5: 535-7(Oct. 1966). (In Russian).

The role of different electronic excitations in the process of coloration of NaCl single crystals by ionizing radiation is investigated. It is shown that the color centers may be created by selective generation of electrons, excitons, electron-hole pairs and electronic excitations of higher energy in the crystal. For the effective generation of F centers in NaCl crystals by x rays the participation of mobile holes is necessary. The electronic-hole mechanism of creation of color centers in ionic crystals is discussed. (auth)

9651 DEPOSITION OF THIN FILMS UNDER THE INFLUENCE OF FAST ION IRRADIATION. Krimmel, E. F.; Gordon, A. (Univ. of Illinois, Urbana). Contract AT(11-1)-1198. Z. Angew. Phys., 22: 1-4(1966). (COO-1198-346).

Thin films are produced by the simultaneous deposition of neutral atoms and ionized fast atoms of the same kind. They are of considerably higher mechanical stability and show higher optical reflection coefficients than films resulting from only neutral atoms. The deposition conditions are otherwise similar. The ion currents produced by the ion gun were up to 10 mA. (auth)

9652 DETERMINATION OF LONGITUDINAL AND TRANSVERSE OPTICAL CONSTANTS OF ABSORBING UNIAXIAL CRYSTALS: OPTICAL ANISOTROPY OF GRAPHITE. Ergun, S. (Bureau of Mines, Pittsburgh). Nature, 213: 135-6(Jan. 14, 1967).

A uniaxial crystal may be defined as a stratified medium, whose properties are constant throughout each plane perpendicular to the optic axis. In order to define the medium optically it is necessary to know the dielectric constants along and perpendicular to the optic axis. The optical properties of graphite are defined as transverse when the electric vector is perpendicular to the optic axis and as longitudinal when the electric vector is parallel to the optic axis. Many uniaxial crystals exhibit natural surfaces perpendicular to the optic axis and measurement of reflectance at normal incidence to such surfaces leads to determination of the transverse optical properties. Equations relating the minimum values of the refractive and absorption indices to the longitudinal and transverse optical constants are developed, and the longitudinal optical constants of graphite obtained. (UK)

9653 ELECTRONMICROSCOPIC OBSERVATIONS OF THE EFFECT OF ELECTRON IRRADIATION AND PRINT-OUT EFFECT ON AgBr CRYSTAL. Iijima, Sumio; Hibi, Tadatosi (Tohoku Univ., Sendai). Jap. J. Appl. Phys., 5: 1182-9(Dec. 1966).

The effects of the electron irradiation on the two kinds of silver bromide microcrystals which were prepared from the photographic process plate and the SSS photographic film were studied. The print-out effect on the specimens from the SSS film were observed directly and by using replica with an electronmicroscope. It was found that whiskers grew from the side face of the grain with intense electron irradiation, while the (111) surface showed no appreciable change. In the crystals from the SSS photographic film the triangular pattern consisting of three protrusions appeared on the well-developed (111) surface, while the square pattern appeared on the (100) face with electron irradiation or exposure to the sun light. It was also found that the tripyramidal pits appeared on the (111) face with much longer electron irradiation or exposure to the sun light. (auth)

9654 MEASUREMENT OF RESISTANCE BY MEANS OF ELECTRON BEAMS. II. Munakata, Chusuke; Watanabe, Hiroshi (Hitachi, Ltd., Tokyo). Jap. J. Appl. Phys., 5: 1156-9 (Dec. 1966).

Resistance of semiconductor materials was measured by using a focused electron beam. The experimental error was mainly due to the bulk electron voltaic effect in the material. To reduce the error, the surface of the specimen was sand-lapped. After the treatment the electron beam technique was successfully applied to semiconductor materials, within the error of a few per cent. Energy and current of the electron beam were in the range of 5 to 30 keV and approximately 1 μA, respectively. (auth)

9655 MILLIMETRIC DIODES ON BOMBARDED SILICON. Petit, C. (Compagnie Generale de Telegraphie sans Fil, Paris). Ann. Radioelec., 21: 306-11(Oct. 1966). (In French).

The fabrication of point-contact diodes to be used for frequency conversion in the millimetric band cannot be envisaged in the case of a homogeneous semiconductor. Investigation with a view to minimum conversion loss leads to defining a geometry with two clearly different regions. On n-type silicon of low resistivity, chosen in order to ensure a low series resistance, a region of much higher resistivity is produced, limited to some thousands of angstroms. This layer is obtained by bombarding the surface with helium ions accelerated by means of an electrostatic generator delivering a maximum voltage of 80 kV. Points made from a 50-μ-diam. wire are obtained by electrolytic etching in a sodium chloride solution; their final diameter is about 2 μ. The quality of the diodes depends on the nature of the silicon-point contact; pressure alone is not sufficient; it is necessary to form the diodes by means of electrical pulses applied in the forward direction. The diodes are mounted in a coaxial case which ensures both mechanical stability and adaptation for a 75-Gc frequency. (auth)

9656 NUCLEAR ORIENTATION IN FERROMAGNETIC DILUTE ALLOYS. Kamitsubo, Hiromichi (Tokyo Univ.). Jap. J. Appl. Phys., 5: 1056-64(Nov. 1966).

Nuclear orientation in ferromagnetic dilute alloys was developed with a thermal equilibrium method. A sample of small iron plate containing the dilute radioisotopes was cooled to 0.014°K indirectly by adiabatic demagnetization. Temperature of the sample was determined from anisotropy of gamma rays of ^{60}Co. Details of design consideration and performance are discussed. (auth)

9657 OPTICAL ABSORPTION AND PARAMAGNETIC RESONANCE OF COLOR CENTERS IN X-RAYED α-QUARTZ CONTAINING GERMANIUM. Haven, Y.; Kats, A.; van Wjeringen, J. S. Philips Res. Rep., 21: 446-76(Dec. 1966).

The electron centers in α quartz containing germanium which are produced upon irradiation with x rays have been studied by paramagnetic resonance and by optical absorption. In accordance

with the results of other workers, mainly three types of electron centers were found: the B center which is an electron trapped by a germanium impurity and its four nearest oxygen neighbors, and the A and C centers which are also electrons trapped at germanium and its neighbors but compensated by monovalent impurities. The deviations of the magnetic moments from the free-electron values are explained by the contribution from the nearest oxygen neighbors. The interconversion of the several centers is explained by the migration of monovalent impurities and of electrons or electron holes. (auth)

9658 F-COLORABILITY DECAY IN POTASSIUM HALIDE POLYCRYSTALS. Gibbon, C. F.; Kuczynski, G. C. (Univ. of Notre Dame, Ind.). J. Chem. Phys., 46: 814-15(Jan. 15, 1967).

Potassium halide powders of different grain sizes were pressed into pellets, and the pellets were irradiated by ^{60}Co γ rays for 20 min after being aged for different lengths of time. The number of F centers produced by the irradiation was measured as a function of the time between pressing and irradiation. The density of F centers produced in the pressed pellets decayed rapidly at room temperature to values characteristic of an annealed single crystal. The rate of decay also depended on the particle size. The results are discussed briefly in terms of the behavior of grain boundaries as defect sinks. (A.G.W.)

9659 ENERGY LEVELS OF Np^{3+} IN $LaBr_3$. Krupke, William F.; Gruber, John B. (Univ. of California, Los Angeles). J. Chem. Phys., 46: 542-62(Jan. 15, 1967).

The polarized absorption and emission spectra of single crystals of $LaBr_3$ doped with nominally 0.15% and 0.75% ^{237}Np have been recorded between 5000 and 25,000 cm^{-1} at temperatures of liquid helium and nitrogen. Fluorescence excitation spectra and both parallel and perpendicular Zeeman spectra were also recorded. Based on the number, polarization, and magnetic behavior of Stark components appearing in distinct groups, as well as on preliminary 5f-hydrogenic calculations, 14 absorption groups were identified as levels on the ground electronic configuration $5f^4$ of Np^{3+}. The assumption of a pure $5f^4$ electronic configuration does not lead to a satisfactory interpretation of the spectrum; however, the inclusion of electrostatic configuration interaction permits a satisfactory fitting of the observed levels with an rms deviation in energy of 86.4 cm^{-1} using the parameters: $E^1 = 3394.3 \pm 29.1$, $E^2 = 14.19 \pm 0.22$, $E^3 = 317.5 \pm 1.9$, $\zeta_{5f} = 1969.2$ 10.8, $\alpha = 35.0 \pm 2.2$, and $\beta = -802.4 \pm 11.3$ cm^{-1}. Twenty-five crystalline-field-split Stark components of the $^5I_{4,5,6,7}$ levels of the ground multiplet were used to perform a first-order crystal-field perturbation calculation. An rms deviation in energy of 8.0 cm^{-1} is obtained using the parameters: $B_2^0 = -22.8 \pm 8$, $B_4^0 = -86.7 \pm 2.4$, $B_6^0 = -70.8 \pm 0.9$, $B_6^6 = +857.1 \pm 12.0$ cm^{-1}. The negative value obtained for B_2^0 represents a crystal-field shielding in excess of 100% and is discussed in some detail. Parallel and perpendicular Zeeman interactions are also discussed in some detail. (auth)

9660 MAGNETIC SUSCEPTIBILITIES OF CUBIC UO_{2+x} AT HIGH TEMPERATURE. Nasu, Shoichi (Japan Atomic Energy Research Inst., Tokaimura). Jap. J. Appl. Phys., 5: 1001-6(Nov. 1966).

Magnetic susceptibilities of cubic UO_{2+x} ($x = 0.00_3 - 0.24_8$) were measured over the temperature range between 77 and 1100°K. Susceptibilities of UO_2 single crystals follow the Curie-Weiss law with a high value of the Weiss constant (−22$_0$°K). The phase boundaries between one phase (UO_{2+x}) and two phases (UO_{2+y} and U_4O_{9-y}) in helium atmosphere were obtained from the breaks in the inverse susceptibility-temperature relations of the intermediate oxides from UO_2 up to U_4O_9. The susceptibility data of UO_2 and U_4O_9 were discussed in terms of the ground state configuration f^2 perturbed by the crystalline field, in connection with the results of neutron diffraction. (auth)

9661 MAGNETIC SMALL-ANGLE SCATTERING OF SUBTHERMAL NEUTRONS ON DISLOCATIONS IN POLYCRYSTALLINE NICKEL. Stork, Adolf (Technische Hochschule, Munich). Z. Phys., 198: 386-408(1967). (In German).

The stress fields of dislocations in a ferromagnetic crystal produces variations of the magnetization across magnetostrictive interaction in the vicinity of the dislocation nuclei. According to a theory of Kronmueller, Seeger and Wilkens subthermal neutrons undergo a magnetic small-angle scattering on these inhomogeneities. This theory can be confirmed regarding their evidence about magnetic field and angular dependence of scattering on polycrystalline nickel specimens plastically deformed at 78°K. Measurements on various strongly deformed specimens showed that the dislocation density increases linearly with the dislocation stress applied, while the mean state between opposite dislocations appear to remain constant. (tr-auth)

9662 THE EFFECT OF CRYSTALLIZATION CONDITIONS ON RADIATION-INDUCED CROSSLINK FORMATION IN POLYETHYLENE. PART VI. SOME EFFECTS IN THE BULK MATERIAL. Kawai, T.; Keller, A. (Bristol Univ., Eng.). Phil. Mag. (8), 14: 1123-30(Dec. 1966).

It is found that insolubility induced by a given radiation dose can be variable also in melt-crystallized material depending on prehistory. In analogy to solution-crystallized material this is attributed to the differences in the effectiveness of crosslinks in samples of differing morphologies reflecting variations in molecular coordination. It follows that solubility methods are insufficient to define the crosslink content even in the bulk. In particular the effects of primary crystallization and annealing treatments were followed as regards radiation-induced insolubility, long spacings, and density. A resemblance in trend was noticed between the long time end of the primary crystallization and heat annealing as regards all three properties. This trend is consistent with expectations of isothermal lamellar thickening and for molecular fractionation during primary crystallization. (auth)

9663 ESR OF NIOBIUM IN $CaWO_4$. Chu, K. C. (Univ. of Michigan, Ann Arbor); Kikuchi, C.; Viehmann, Walter. J. Chem. Phys., 46: 386-7(Jan. 1, 1967).

The Nb resonance was observed in $CaWO_4$:Nb irradiated for about 1 hr in a ^{60}Co source ($\sim 10^6$ rads). In the crystal ab plane, the Nb resonance consists of two groups of 10 lines, corresponding to the nuclear spin $I = 9/2$ for ^{93}Nb. Along the c axis there is a single group of 10 lines. At −78°C the groups coalesce such that $g = 2.026$ and 2.023 along the [110] and [001] directions, respectively. The positive Δg and the small hyperfine coupling constant are taken as evidence that Nb occupies the covalent W site. (A.G.W.)

9664 DYNAMICS OF PLASTIC FLOW AT CONSTANT STRESS IN NaCl SINGLE CRYSTALS. Agullo-Lopez, F. (Junta de Energia Nuclear, Madrid). Phil. Mag. (8), 14: 1115-22(Dec. 1966).

Experimental room-temperature transient creep curves of unirradiated as well as γ- and reactor-irradiated NaCl single crystals are presented. A very simple dynamic model, which gives a fairly good semi-quantitative agreement with experiments is described. (auth)

9665 ESR SPECTRA FROM PARAMAGNETIC CENTERS IN IRRADIATED $KClO_4$. I. THE ClO_2 CENTER. Byberg, J. R.; Jensen, S. J. K.; Muus, L. T. (Univ. of Aarhus, Denmark). J. Chem. Phys., 46: 131-7(Jan. 1, 1967).

Accurate spin Hamiltonians for one paramagnetic center in irradiated $KClO_4$ are derived from ESR spectra at five temperatures in the range from −170 to 0°C. The quadrupole interaction gives rise to "forbidden" transitions of high intensity. An iterative procedure is used for computation of the principal values of the g tensor as well as the tensors for the magnetic and electric hyperfine interaction. Comparison of the low-temperature spin Hamiltonian for the center with that derived from microwave spectra for the free ClO_2 molecule demonstrates that the center is adequately described in terms of a trapped ClO_2 molecule as previously suggested by Cole. A pronounced temperature dependence of the spin Hamiltonian indicates a considerable influence of the host lattice. (auth)

9666 SOME COMMENTS ON THE MASS EFFECT IN DIFFUSION. Le Claire, A. D. (Atomic Energy Research Establishment, Harwell, Eng.). Phil. Mag. (8), 14: 1271-84(Dec. 1966).

An alternative derivation is given of Mullen's (1961) relation $(w^\alpha/w^\beta) - 1 = \Delta K((m^\beta/m^\alpha)^{1/2} - 1)$ between the ratio of the diffusion jump frequencies of two isotopes w^α/w^β and the ratio of their masses m^α/m^β. A connection is suggested between the kinetic energy factor ΔK and relaxation around defects. It is pointed out that when $\Delta K \neq 1$ Schoen's equation (1959) for the isotope effect cannot be exact and the nature of the corrections necessary is discussed. Finally, quantum corrections to the classical rate equations for atomic jump frequencies are discussed and shown to be important in considering mass effects for diffusion in metals of light interstitial solutes such as H_2 and D_2. (auth)

9667 DEPOSITION AND DIFFUSION OF DEUTERONS IN GOLD, NICKEL, AND COPPER. Heintze, V.; Kamke, D. (Ruhr-Univ., Bochum, Ger. Philipps Univ., Marburg, Ger.). Appl. Phys. Lett., 10: 12-13(Jan. 1, 1967).

The energy spectrum of the D(d,p)T protons shows that with gold foils a surface and an inner part of imbedded deuterons exist, whereas solid gold gives only an inner part, solid copper and nickel only surface parts. (auth)

9668 THEORY OF THE LATTICE VIBRATIONAL PROPERTIES OF SOLID HYDROGEN AND DEUTERIUM. Sattar, Abdus. Toronto, Univ. of Toronto, 1965.

Thesis.

A theoretical investigation of the effects of the lattice vibrations on the cohesive and optical properties of solid hydrogen and deuterium is presented. The lattice vibrations in a crystal of solid hydrogen depend sensitively on the shape of the intermolecular potential at distances comparable with the lattice constant. The additive Lennard–Jones model is found to be inadequate to describe the interaction between the molecules in the lattice. The more realistic exp-6 model is therefore used for the pair potential in solid hydrogen and deuterium. The parameters of the exp-6 model are determined from the observed second virial coefficient over a wide range of temperature. The effect of the nonadditive potential on the cohesive energy of the lattice is also studied. It is found that the triple-dipolar forces in solid hydrogen are much weaker than the additive forces, and do not affect the lattice vibrations appreciably. The effect of the intermolecular potential on the stability of the hcp and the bct lattices, which are possible crystal structures of solid hydrogen, is investigated in detail. By solving the secular equation in the limit of long waves it is shown that the lattice becomes unstable if the nearest neighbors lie beyond the inflection point of the intermolecular pair potentials. In the case of the bct lattice the distant neighbors play an important role in determining the stable configuration; the lattice is stable only if the interactions of the central molecule with all the neighbors beyond the second shell are neglected. The various deformations of the lattice, which lead to instability, are considered. The lattice vibrational spectra of solid hydrogen and deuterium are calculated on the basis of the exp-6 model. The smooth representations of these spectra and the associated branches are obtained from a detailed analysis of the critical points and the nature of the corresponding singularities. The zero-point energies of the hcp and the bct lattices are obtained from the vibrational spectra. A comparison of the free energies of the hcp and the bct lattices shows that for all temperatures up to the melting points the hcp structure is energetically more favorable for solid para-hydrogen than the bct structure. However, the harmonic theory is found to be inadequate to establish the absolute stability of the hcp lattice, and the problem needs further consideration. Finally, the results of the calculation of the lattice vibrational spectrum are used to evaluate the line shape of the one-phonon branch of the $Q_1(0)$line in solid parahydrogen. (Dissertation Abstr.)

9669 SPIN-LATTICE RELAXATION STUDIES IN SOME RARE EARTH SALTS. Larson, Gary Hollis. Berkeley, Calif., Univ. of California, 1966. 186p.

Thesis.

Some experimental investigations of spin-lattice relaxation at liquid helium temperatures carried out on a number of hydrated rare earth salts are described. By observing the transient recovery of the microwave paramagnetic resonance signal at a frequency of 9.3 kMc/sec, measurements of the spin-lattice relaxation rate T_1^{-1} for Pr, Nd, Sm, and Er in lanthanum ethyl sulfate; Ce, Pr, Nd, Sm, Tb, and Er in yttrium ethyl sulfate; and Ce, Pr, Nd, Sm, and Dy in lanthanum magnesium nitrate were made. The dependence of the spin-lattice relaxation rate on the temperature T and on both the magnitude of the magnetic field and its orientation with respect to the crystalline axis, together with the effects of hyperfine interactions was investigated. All of the expected temperature dependences, $T_1^{-1} \propto T$, T^7 or T^9, and $e^{-\Delta/T}$, are found, in addition to two cases of a bottlenecked direct process giving a T^2 dependence. For constant frequency and temperature the experimental results indicate that the one phonon or direct process for Kramers salts alone shows dependence on the orientation of the magnetic field with respect to the crystalline axis; however, a small correction is found to be necessary in one case for the Orbach process. The value of the crystal field splitting Δ is found to be quite sensitive to crystal environment for at least one ion, Ce in the ethyl sulfate, where temperature dependence studies on a number of concentrated ethyl sulfate crystals, doped with Ce, indicate a shift of at least 30 cm^{-1} in the experimental value of Δ. Hyperfine effects are found to be apparently important in the low temperature region where only the direct process remains. All of these experimental results are explained reasonably well using a phenomenological approach which previously has been shown to be applicable to the rare earths. A computer program used to carry out the actual theoretical calculations is described. Additional relaxation studies are described which deal with the effects of cross relaxation between two spin systems. The rate equations and associated time constants are discussed and then applied to a specific case. The experimental results are quite adequately explained by this approach. (Dissertation Abstr.)

9670 STUDY OF DEFECTS INTRODUCED IN GERMANIUM BY 6 TO 88 MeV ELECTRON BOMBARDMENT. Fischer, John Edward. Troy, N. Y., Rensselaer Polytechnic Inst., 1966. 164p.

Thesis.

Two classes of defect acceptor levels, three classes of minority hole traps, and recombination centers are introduced by 48-MeV electron bombardment of As- and Sb-doped (n-type) germanium at 85°K. The recovery of traps and acceptors occurs in five stages, centered at 150°K, 200°K, 360°K, 460°K, and about 540°K, suggesting that the traps and acceptors are due to the same defects (the dominant acceptor levels are below the middle of the gap, and the dominant trapping levels are within 0.16 eV of the valence band). The recombination centers recover completely below 200°K. After 300°K irradiation with 6-, 47-, and 88-MeV electrons, the trapping level is 0.10 ± 0.01 eV above the valence band in all samples (As- or Sb-doped). The introduction rate and recovery behavior of this trapping level is independent of As and Sb concentration up to 2×10^{15} donors/cm^3. The decay of excess carriers is analyzed in terms of the large-injection model due to Baicker. The assumptions inherent in this model are criticized in light of the present results. The effect of chemical impurities on the nature and recovery of the various defects is discussed. (Dissertation Abstr.)

9671 STUDY OF THE 1.8, 3.3, AND 3.9 MICRON RADIATION-INDUCED ABSORPTION BANDS IN SILICON. Cheng, Li-Jen. Troy, N. Y., Rensselaer Polytechnic Inst., 1966. 128p.

Thesis.

The annealing behavior and the uniaxial stress responses of the radiation-induced defects causing the 1.8-, 3.3-, and 3.9-micron infrared absorption bands were studied after 45-MeV electron and fast-neutron irradiation. The results strongly suggest that these three bands arise from the same defect, which can assume three different charge states. The defect exhibits two kinds of stress response, one due to electronic redistribution and the other due to atomic redistribution among the allowable orientations. The defect has an atomic symmetry along a ⟨111⟩ direction and a transition dipole along a ⟨110⟩ direction. The activation energies for atomic reorientation and for annealing of the defect are the same, about 1.2 eV. The defect is annealed out by means of a process of diffusing to a sink in crystals. The main sinks in the pulled crystal are found to be the oxygen impurities. Our data fit well the conclusion that the defect in question is the divacancy for which a detailed model was first given by G. D. Watkins and J. W. Corbett. A new radiation-induced broad absorption band has been found and is located in the wavelength range from the fundamental absorption edge of the silicon crystal up to higher wavelengths. The intensity of the band is a monotonically decreasing function of wavelength and appears in both n- and p-type silicon after irradiation. (Dissertation Abstr.)

Theoretical Physics

9672 (UCRL–14306) THEORY AND GENERAL CHARACTERISTICS OF PLANCK BLACKBODY RADIATION. Buhl, David (California Univ., Livermore. Lawrence Radiation Lab.). Apr. 13, 1966. Contract W-7405-eng-48. 23p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The general laws governing blackbody radiation are scattered throughout many physics and engineering texts. They are gathered here in a concise form so that they can be easily applied. Most of the equations of Planck radiation are derived, and comments are made about their significance. Several plots of Planck radiation spectra are included, and an example of a blackbody problem is worked out. Consideration is given to the problem of the effect of temperature fluctuations on the power output in a given wavelength band. It is shown that the blue end of a blackbody spectrum is extremely sensitive to temperature changes. This analysis is particularly useful when attempting to use a blackbody as a radiation standard. (auth)

9673 ASTROPHYSICAL CONSEQUENCES OF GRAVITATIONAL MONOPOLE RADIATION. Sexl, Roman U. (Univ., Vienna). Z. Astrophys., 65: 45-7(1967).

It has been shown previously that light deflection larger than predicted by general relativity can be explained by a scalar gravitational field with negative energy. The emission of gravitational waves with negative energy might be the energy source of the quasars. (auth)

9674 SOLUTION OF THE DIRAC EQUATION FOR A CLASS OF POTENTIALS. Verbeure, A. (Univ., Louvain, Heverlee, Belg.). Ann. Soc. Sci. Brux. Ser. I, 80: 302-9(Dec. 28, 1966).

The Dirac equation in an electromagnetic propagating wave is solved. The work of Wolkow, who solved the equation for plane waves, is extended. A new method is followed which leads to an easier physical interpretation and a more practical form of the solution. Finally the applicability of the method to other potentials is discussed. (auth)

9675 MOTION IN AN ELECTRIC FIELD OF A NEUTRAL FERMION HAVING AN ANOMALOUS MAGNETIC MOMENT. Ternov, I. M.; Bagrov, V. G. (Moscow State Univ.). Dokl. Akad. Nauk SSSR, 168: 1298-9(June 21, 1966). (In Russian).

An exact solution of the Dirac equation is obtained for the interaction of a neutral fermion with a static coulombic field of a particular type. It is shown that a discrete energy spectrum is obtained that depends only on a single quantum number n = 0, 1, 2, ... The solution corresponds physically to the motion of a particle along a circle lying in a plane parallel to the z axis and passing through the vector $p = (p_1, p_2)$. Expressions are given for the radius of the circle and for the position of the orbit center. (TTT)

9676 ON THE FARRI-SOMMERFELD-MAUE APPROXIMATION. Boldshev, V. F. Ukr. Fiz. Zh., 11: 1277-85(1966). (In Ukrainian).

A general derivation of the wave functions of an electron in a Coulomb field in the Farri-Sommerfeld-Maue approximation is given. The approximation error is estimated. The error decreases linearly with an increase in the partial wave moment. (auth)

9677 ELECTROMAGNETIC POTENTIALS IN LANDAU GAUGE. Lukierski, J. (Univ., Wroclaw). Bull. Acad. Pol. Sci., Ser. Sci., Math. Astron. Phys., 14: 569-72(1966).

It is well known that the commutators of the electromagnetic potentials A^L_μ characterizing Landau-Khalatnikov gauge (1) $i[A^L_\mu(x), A^L_\nu(x')] = g_{\mu\nu}\tilde{D}(x-x') - \partial_\mu\partial_\nu(x-x')$, where D is Lorentz invariant, local, and satisfies the equation $\Box\tilde{D}(x) = D(x)$, are consistent with the strong Lorentz condition (2) $A^{L\mu}_\mu(x) = 0$. Four operators A^L_μ are constructed which satisfy the relations (1) and (2). (W.D.M.)

9678 EFFICIENCY OF GENERATION AND POSSIBLE OBSERVATION OF GRAVITATIONAL RADIATION. Westervelt, Peter J. (Brown Univ., Providence). JETP Lett. (USSR) (Engl. Transl.), 4: 225-8(Nov. 1, 1966).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Redaktsiyu, 4: 333-8(Nov. 1, 1966).

The practical realizability of recently proposed experiments on the generation and observation of gravitational waves is discussed. The classical theory of gravitational bremsstrahlung is used to estimate the upper limit of efficiency of the generation of gravitational energy. (W.D.M.)

9679 POSITION DEPENDENCE OF LANDAU-SUSCEPTIBILITY. Baltensperger, W. Phys. Kondens. Mater., 5: 341-6 (1966). (In German).

The orbital magnetization, which depends linearly on a nonuniform magnetic induction, was calculated for a perfect and degenerate Fermi gas. (auth)

9680 ON THE THEORY OF BROWNIAN MOTION IN A QUANTUM BOSE FLUID. Dagonnier, R.; Resibois, P. Bull. Cl. Sci., Acad. Roy. Belg. (5), 52: 229-47(1966). (In French).

The general theory of the irreversible processes developed by I. Prigogine is applied to the particular problem of the movement of a heavy charged particle (mass M) in a fluid of bosons (mass m: $\gamma = (m/M)^{\frac{1}{2}} \ll 1$) under the influence of an external electric field. Results similar to those obtained recently by P. Resibois and H. T. Davis were obtained: at the lower γ order, the Brownian particle obeys a classic Fokker-Planck equation but with a quantum friction coefficient. The friction constant of a heavy ion immerged in a diluted Bose fluid was evaluated explicitly as an application of this method; the result obtained is in satisfactory agreement with the experiments of I. Meyer and F. Reif on liquid ^{4}He. (tr-auth)

9681 HAMILTONIAN EQUATIONS IN GENERAL RELATIVITY. Roche, Claude (College de France, Paris). Cah. Phys., No. 191, 265-75(July 1966). (In French).

Field equations resulting from a variational principle allow a Hamiltonian form on a Riemannian variety if the space is a minimal hypersurface. After discussing this condition, the case of an electromagnetic field is taken, and a quantitative method is outlined. (auth)

9682 VARIATIONAL PROBLEM IN THE SCHROEDINGER THEORY. Gaspar, R. (Research Group for Theoretical Physics, Budapest). Acta Phys. Acad. Sci. Hung., 21: 377-9(1966).

With integrated forms of the one particle Schroedinger equation a variational principle is presented and applied to some simple problems. Armstrong earlier discussed an interesting special form of the integrated Schroedinger equation. This idea is generalized and a variational principle is discussed for the determination of the wave function and energy eigenvalue. (M.O.W.)

9683 RELATIVISTIC PRECESSION OF A SPINNING SATELLITE. Rastall, Peter (Univ. of British Columbia, Vancouver). Can. J. Phys., 44: 3109-19(Dec. 1966).

The precession of the spin angular velocity of a small, spherically symmetric satellite is calculated by a geometrical method. The gravitational field is not assumed to be spherically symmetric, and metrics of the Lense-Thirring type are allowed. (auth)

9684 ON THE QUANTUM MECHANICAL TRANSITION DENSITY OPERATORS. I. FOUNDATIONS. Peltzer, C.; Brandstatter, J. J. (Stanford Research Inst., Menlo Park, Calif.). J. Math. Anal. Appl., 16: 472-85(Dec. 1966).

The hierarchy of transition density operators $D^p(\psi,\phi)$, (p = 1, 2, ..., n) associated with an ordered pair of n-particle wave functions ψ,ϕ is treated. It is shown that the principal properties of the transition density operator follow directly by a systematic application of the cross operator. Some immediate supplementary characterizations of $D^p(\psi,\phi)$ are given when both wave functions ψ and ϕ are either symmetric (bosons) or antisymmetric (fermions). (L.B.S.)

9685 GOEDEL-TYPE UNIVERSE FILLED WITH CHARGED-INCOHERENT MATTER. Raval, H. M.; Vaidya, P. C. (Gujarat Univ., Ahmedabad, India). Curr. Sci. (India), 36: 7(Jan. 5, 1967).

If the magnetic field is chosen to be of the order of 10^{-6} gauss and the mass-density of the order of 10^{-30} gm/cm^3, it is found that the positive-charge excess on the hydrogen-atom of the smoothed-out distribution of the matter in this universe is of the order of $10^{-20}e$, where e is the charge of an electron. However the order $10^{-20}e$ of the charge-excess found is in better agreement with the expected value than the value suggested by Lyttleton and Bondi to explain the observed expansion of the universe. This charge-excess explains the presence of the universal magnetic-field of the order of 10^{-6} gauss in intergalactic space. (W.D.M.)

9686 ON THE DERIVATION OF THE BOLTZMANN-LANDAU EQUATION FROM THE QUANTUM MECHANICAL HIERARCHY. Baerwinkel, K.; Grossmann, S. (Univ., Marburg, Ger.). Z. Phys., 198: 277-87(1967).

The general solution of the equation of motion for the quantum mechanical distribution function $f_2(r_1p_1,r_2p_2;t)$ in the two-particle space is given by means of the Schrödinger scattering functions. A special initial condition leads to the usual Boltzmann equation plus density correction terms, which depend on the scattering matrix $t(p',p)$. In the long wavelength limit and in lowest order of $t(p',p)$ the Landau corrections to the simple Boltzmann streaming part are obtained. (auth)

9687 EXACT EXPRESSIONS FOR THE ENERGY CURRENT AND STRESS TENSOR OPERATORS IN MANY-PARTICLE SYSTEMS. Kugler, Alfred (Univ. of Illinois, Urbana). Z. Phys., 198: 236-41(1967).

For some purposes in statistical physics, such as, for example, the calculation of various transport coefficients, it is necessary to have expressions for the energy current operator S and stress tensor operator T_{lm}. It is shown that by using a simple identity, exact expressions for S and T_{lm} which satisfy the conservation laws for the energy density ϵ and momentum density P, respectively, exist. S and T_{lm} can each be written as a sum of two parts, $S = S^{(A)} + S^{(B)}$, $T_{lm} = T^{(A)}_{lm} + T^{(B)}_{lm}$. The "A" part is the ordinary convective or kinetic part while the "B" part is shown to be expressible as a gradient and hence its homogeneous component vanishes identically. The expressions are compared with approximate forms found in the literature. The operators are Fourier analyzed and written in terms of the field operators in the second quantization formalism. (auth)

9688 ACCIDENTAL DEGENERACY. Greenberg, David F. (Univ. of Chicago). Amer. J. Phys., 34: 1101-9(Dec. 1966). (COO-264-302; EFINS-66-7).

A detailed discussion of nongeometric, or "accidental," degeneracy is presented in the context of Newtonian, relativistic, and quantum mechanics. An analogy with broken symmetries in elementary-particle physics is used to present an elementary discussion of certain recent developments in theoretical high-energy physics. (auth)

9689 GRAVITATIONAL PARADOX. Levy-Leblond, Jean-Marc; Thurnauer, Peter (Univ. of Rochester, N. Y.). Amer. J. Phys., 34: 1110-15(Dec. 1966). (UR-875-140).

Adapting an argument by Dyson in quantum electrodynamics, it is pointed out that the attractive and long-range character of the gravitational interaction may seem to prevent the universe from being stable against decay into successively lower energy states. A straightforward solution to this paradox is given, based on the essentially nonlinear nature of gravitational theory. This nonlinearity, whose importance is thus clearly demonstrated, is shown to have a very elementary origin. A simple approximation, incorporating the nonlinear effects in a physically transparent way, quantitatively substantiates the intuitive argument. (auth)

PHYSICS (HIGH ENERGY)

Particle Interactions and Properties (Experimental)

Electromagnetic

9690 PHOTOPRODUCTION OF ω, φ, η, AND X^0 MESONS AT ENERGIES UP TO 5.8 GeV. Erbe, R. (Technische Hochschule, Aachen); Reimann, G.; Schuettler, E. (and others). Nuovo Cimento (10), 46A: 795-802(Dec. 21, 1966).

Experimental results are presented of effective-mass distributions, cross sections, and angular distributions for the photoproduction of ω, φ, η, and X^0 mesons on protons at photon laboratory energies up to 5.8 GeV. A combination of various models was used to fit the data. (L.B.S.)

9691 MEASUREMENT OF THE DOUBLE COMPTON CROSS SECTION. McGie, M. R.; Brady, F. P.; Knox, W. J. (Univ. of California, Davis). Contract AT(11-1)-Gen-10. Phys. Rev., 152: 1190-4(Dec. 23, 1966). (UCD-CNL-53).

The differential cross section for the double Compton process was measured as a function of the independent final photon energy with the two detectors at 90° to each other and to the incident beam. The energy of the incident photons was 661.6 keV as produced by a 6-Ci ^{137}Cs source. The measured differential cross section and the cross section integrated over energy agree with the theory, the latter to within 3.5% which is within an estimated experimental error of 5%. (auth)

9692 VALIDITY OF QUANTUM ELECTRODYNAMICS AT SMALL DISTANCES. Asbury, J. G. (Deutsches Elektronen-Synchrotron, Hamburg); Bertram, W. K.; Becker, U.; Joos, P.; Rohde, M.; Smith, A. J. S.; Friedlander, S.; Jordan, C.; Ting, C. C. Phys. Rev. Lett., 18: 65-70(Jan. 9, 1967).

The yield of wide-angle electron-positron pairs produced in the reaction $\gamma + C \rightarrow e^+ + e^- + C$ in order to test the validity of quantum electrodynamics (QED) at small distances. The experiment at the (DESY) 6.2-GeV electron synchrotron, used a symmetrical magnetic spectrometer and counter techniques to detect the pairs. The results show that first-order QED correctly predicts the e^+e^- pair yield for momentum transfers to the virtual electron up to 400 MeV/c, in contradiction to earlier results where large deviations were reported. (B.G.D.)

9693 ETA PHOTOPRODUCTION IN THE REGION FROM THRESHOLD TO 940 MeV. Prepost, R.; Lundquist, D.; Quinn, D. (Stanford Univ., Calif.). Phys. Rev. Lett., 18: 82-6(Jan. 16, 1967).

The photoproduction of the meson (η^0) was measured in the region from threshold to 940 MeV. The differential cross section for this reaction $\gamma + p \rightarrow \eta^0 + p$ showing the results around 100° in the cms is shown versus energy. The differential cross section for this reaction at 790 MeV photon energy versus the cosine of the cms meson angle is also given. Either an S or P wave with $T = \frac{1}{2}$ and $J = \frac{1}{2}$ near threshold is deduced. It is suggested that the meson (η^0) production near threshold is to be identified with the $N_\eta^*(1550)S_{11}$ state. (J.F.P.)

9694 ETA MESON PHOTOPRODUCTION IN THE REGION OF THE THIRD NUCLEON RESONANCE. Prescott, Charles Young. Pasadena, Calif., California Inst. of Tech., 1966. 136p.

Thesis.

The differential cross section for the photoproduction reaction $\gamma + p \rightarrow \eta^0 + p$ was measured in the energy region about the N*** (1688, $\frac{5}{2}^+$) and at an angle $\theta_\eta^* = 45°$. The eta was detected through its two photon decay mode $\eta^0 \rightarrow \gamma + \gamma$. Two thin foil spark chambers and an aluminum plate range chamber are used to measure the lab angle and energy of the outgoing proton and two shower counters measure the energies of the decay photons and the lab angle of the η^0. Overdetermined kinematical parameters allow the mass of the two photon object to be measured. A striking peak centered at 549.9 ± 1.5 MeV on top of a small, broad background indicates a clean selection of eta mesons. Comparison of the measured ratio $N^{***} \rightarrow \eta^0 p / N^{***} \rightarrow \pi^0 p$ provides an experimental measure for the ratio $G_{\eta NN^{***}}/G_{\pi NN^{***}}$ to be compared with predictions of unbroken unitary symmetry. This ratio confirms that the N*** (1688) belongs to a $J = {}^5/_2{}^+$ baryon octet, and gives experimental limits for the F/D coupling ratio for (PS B B*) couplings. (Dissertation Abstr.)

Weak

9695 MEASUREMENT OF THE $K_L^0 \rightarrow \pi\mu\nu$ ABSOLUTE DECAY RATE; FURTHER RESULTS ON $K_L^0 \rightarrow \pi e\nu$, AND MEASUREMENT OF THE K_L^0 MEAN LIFE. Lowys, J. P. (Univ., Paris, Orsay, France); Aubert, B.; Chounet, L. M.; Pascaud, C.; Behr, L. Phys. Lett., 24B: 75-7(Jan. 9, 1967).

A measurement of the $K_L^0 \rightarrow \pi\mu\nu$ absolute decay rate $\Gamma_L^\mu = (4.54^{+}_{-}{}^{.}{}^{.}{}^{.}) \times 10^6\ s^{-1}$ is reported. Secondly, as regards the energy dependence of the form factor which appear in the $K^0 \rightarrow \pi e\nu$ decay, the slope $\lambda = 0.08^{+0.0}_{-0.06}$ is estimated. Finally, a measurement of the K_L^0 mean life $\tau_L = (5.0 \pm 0.5) \times 10^{-8}$ sec. is represented. (auth)

9696 MEASUREMENT OF THE K_2^0 MEAN LIFE. Devlin, T. J. (Princeton Univ., N. J.); Solomon, J.; Shepard, P.; Beall, E. F.; Sayer, G. A. Phys. Rev. Lett., 18: 54-7(Jan. 9, 1967).

The mean life of the K_2^0 meson was measured in conjunction with a recent experiment on K_2^0-proton total cross sections. This was accomplished by determining the variation, due to decay in flight, of the momentum spectrum of a K_2^0 beam as a function of distance along the beam. The results for the lifetime and the corresponding total decay rate, respectively are $\tau = (5.15 \pm 0.14) \times 10^{-8}$ sec and $\Gamma = (19.4 \pm 0.5) \times 10^6\ sec^{-1}$. (B.G.D.)

Strong (Baryon-Induced)

Refer also to abstract 9711.

9697 (AERE-Bib-149) NUCLEON–NUCLEON SCATTERING (EXPERIMENTAL ASPECTS). A Bibliography, 1961–1966. Hall, J. L. (Atomic Energy Research Establishment, Harwell (England)). Aug. 1966. 48p. Dep. mn. BIS $1.40. HMSO 7s.

The bibliography includes published articles and unclassified reports on the experimental aspects of nucleon–nucleon (p-p and n-p) scattering at all energies, for the period covered by abstracting journals published between August, 1961 and June, 1966. Antiparticles are not included. (B.G.D.)

9698 (IS-T-115) SIX AND SEVEN PION ANNIHILATION MODES OF 2.7 GeV/c ANTIPROTONS ON PROTONS. Bohning, Daryl Eugene (Ames Lab., Iowa). Nov. 1966. Contract W-7405-eng-82. 46p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Thesis.

The results of an investigation of the annihilation of 2.7 BeV/c antiprotons on protons into six and seven pions are presented. The experiment forming the basis of this investigation was carried out using the 33-BeV Alternating Gradient Synchrotron and the 20'' Shutt liquid hydrogen bubble chamber. A total six-prong cross section of 5.08 ± 0.39 mb is found to be distributed as: $\sigma(\bar{P} + P \rightarrow 3\pi^+ + 3\pi^-) = 1.05 \pm 0.15$ mb, $\sigma(\bar{P} + P \rightarrow 3\pi^+ + 3\pi^- + \pi^0) = 2.18 \pm 0.40$ mb, and $\sigma(\bar{P} + P \rightarrow 3\pi^+ + 3\pi^- + n\pi^0, n \geq 2) = 1.69 \pm 0.55$, the balance going to kaon final states. Rho and ω production in the six and seven pion final states, respectively, are set at 1.0 ± 0.22 mb and 0.5 ± 0.27 mb, with no evidence for f^0 or ρ^1 production. In addition, the six pion final state shows some indication of a newly discovered I = 0 meson state at 1670 MeV. From the data this state is estimated to decay to $\rho + \pi^+ + \pi^-$ and $2\pi^+ + 2\pi^-$ in the ratio four to one. Angular distributions and angular correlations are presented along with discussion of their basic features. (auth)

9699 MAY THE MICROMETEORS CONSIST OF ANTIMATTER? Kuchowicz, Bronislaw. Postepy Fiz., 17: 565-6(1966). (In Polish).

If the comets consist of antimatter, then meteor showers originating in the decays of these comets may exhibit some annihilation properties in their interaction with the earth's atmosphere. Results of investigations show that an increase in hard γ radiation and in neutrons (2% of the background) is observed during the time of observation (by radar techniques) of the meteor track. Observations have been performed during the years 1961–64. The estimated mass of a meteor from antimatter amounts to 10^{-9}–10^{-10} g. (auth)

9700 STUDY OF THE EMISSION OF ENERGETIC HELIUM NUCLEI IN THE NUCLEAR CASCADE. Fain, Jean; Costilhes, Jean-Pierre; Jousset, Jacques (Univ., Clermont-Ferrand, France). Compt. Rend., Ser. B, 263: 1258-60(Nov. 28, 1966). (In French).

The ejection of nuclei Z = 2 with a kinetic energy above 50 MeV induced in nuclear emulsions by 500-MeV protons was studied. The angular and energy distributions of these fragments are given. (tr-auth)

9701 EXPERIMENTAL DATA ON THE K-MESON AND NUCLEON CHARGE EXCHANGE AT HIGH ENERGIES AND COMPLEX ANGULAR MOMENTUM THEORY. Melnikov, V. N.; Ter-Martirosyan, K. A. (Inst. of Theoretical and Experimental

Physics, Moscow). Yadern. Fiz., 4: 1072-6(Nov. 1966). (In Russian).

The K meson and nucleon charge-exchange reactions $K^+n \rightarrow K^0p$, $K^-p \rightarrow \bar{K}^0n$ and $np \rightarrow pn$, $\bar{p}p \rightarrow \bar{n}n$ are considered at high energies, on the basis of the complex angular momentum theory. An experimental investigation of these reactions in the region $E \sim 10$ to 100 GeV can be very important for the theory. (auth)

9702 HYPERON AND ANTIHYPERON PRODUCTION IN $\bar{p}$-p COLLISIONS AT 7 GeV/c. Chien, C. Y. (Yale Univ., New Haven); Lach, J.; Sandweiss, J.; Taft, H. D.; Yeh, N.; Oren, Y.; Webster, M. Contracts AT(30-1)-1807. Phys. Rev., 152: 1171-82(Dec. 23, 1966). (TID-23267).

Production of hyperons and antihyperons in the interactions of 6.935 BeV/c antiprotons with protons was studied. A total of 80,000 pictures taken with the Brookhaven National Laboratory 80-in. liquid-hydrogen bubble chamber were analyzed for all possible final states involving the production of a hyperon and/or an antihyperon. The total cross section for events in this category is 1.3 ± 0.1 mb. Reactions leading to two-, three-, or four-body final states involving Λ or Σ hyperons (or their antiparticles) were produced highly peripherally. The angular distribution of the $\Lambda\bar{\Lambda}$ final state can be fitted to K*(888) exchange when the absorptive effect of competing channels is taken into account. Ratios among cross sections of various hyperon-antihyperon pair states agree with predictions from SU_3 symmetry, assuming a dominant K or K* exchange and an F-type coupling. Charge ratios of events with Σ^+ and $Y_1^{*+}(1385)$ are also consistent with single-particle-exchange models. The mass spectra of all possible mass combinations of all possible final states were examined. The $Y_1^*(1385)$ was by far the most prominent resonance produced, and production of $Y_0^*(1405)$ and $Y_0^*(1520)$ was also observed. Although the energy available in the production center-of-mass system is 3.86 BeV, there was no statistically significant evidence for the production of any new meson or baryon resonance. A thorough search has been made for Ω^- and $\bar{\Omega}^+$ particles, but no event was found to be consistent with their production and decay. (auth)

9703 BOSON PRODUCTION IN p-p COLLISIONS AT 12.3 GeV/c. Anderson, H. L. (Univ. of Chicago); Fukui, S.; Kessler, D.; Klare, K. A.; Sherbrook, M. V.; Evans, H. J.; Martin, R. L.; Hincks, E. P.; Sherman, N. K.; Kalmus, P. I. P. Phys. Rev. Lett., 18: 89-93(Jan. 16, 1967).

The results obtained from a study of p + p inelastic scattering at 12.3 GeV/c are presented. It is shown that the missing mass (MM) spectra of the reactions $p + p \rightarrow p + MM$ and $p + p \rightarrow \pi^+ + MM$ have considerable structure and permit more than 1/4 of the events detected in the configuration to be ascribed to well-defined reactions, the most striking of these being $p + p + \omega^0$ which accounts for about 6% of the reactions of the first type. The missing mass spectra are shown for the events studied. (J.F.P.)

9704 OBSERVATION OF THE B MESON IN THE REACTION $\bar{p} + p \rightarrow \omega^0 + \pi^+ + \pi^-$. Baltay, C.; Steveriens, J. C.; Yeh, N.; Zanello, D. (Columbia Univ., New York. Brookhaven National Lab., Upton, N. Y.). Phys. Rev. Lett., 18: 93-7(Jan. 16, 1967).

The B meson, decaying into $\omega^0 + \pi^\pm$, was observed in $\bar{p}p$ annihilations at rest in the reaction $\bar{p} + p \rightarrow \omega^0 + \pi^+ + \pi^-$. The mass and width of the B meson as observed in this reaction are M = 1200 ± 20 MeV and Γ = 100 ± 30 MeV. (auth)

9705 ANTIPROTON–PROTON ANNIHILATION INTO FOUR AND FIVE PIONS, AT 2.7 BeV/C. Lyon, Donald Edward Jr. Ames, Iowa, Iowa State Univ. of Science and Tech., 1966. 31p.

Thesis.

An investigation of antiproton-proton annihilation into four and five pions at 2.7 BeV/c was carried out at Brookhaven National Laboratory using the Shutt 20" liquid hydrogen bubble chamber. Cross sections for the four and five pion final states are (0.8 ± 0.1) mb and (4.8 ± 0.5) mb, respectively, while the total cross section for the $\bar{p}p$ system going to all four-prongs is (23.7 ± 0.8) mb. The presence of an asymmetry in the angular distributions of the charged pions was confirmed in both channels at this energy; it is due mainly to high energy pions. The production of ρ and f mesons was observed in the four pion channel with rates of ~35% each. The production of ρ and ω mesons was observed in the five pion channel with rates of 16 and 7%, respectively. In addition, an I = 0 meson state of mass value 1630 ± 30 MeV and a width Γ = 140 ± 50 MeV was observed in the five pion channel with a rate of ~5%. The decay of the meson is via $\rho\,2\pi$ or 4π with a ratio $\rho\,2\pi$ to all decays of $0.7^{+0.3}_{-0.3}$. Also, there is some indication of its presence in the four pion channel with a $\pi^+\pi^-$ decay mode. A search for the decay mode $\pi^+\pi^-\pi^0\pi^0$ in the unconstrained events proved unsuccessful. Derivation of the quantum numbers of the meson, proposed to be called the G, shows that they are all plus, and that the spin is even. Reliability of the analysis was checked using artificially generated events and by constructing four-prong events from real six-prong events that fit the 6π hypothesis uniquely. The result was that the resonance effect could not be attributed to experimental biases. (Dissertation Abstr.)

9706 SCATTERING OF Σ^+ AND Σ^- HYPERONS ON HYDROGEN. Stark, Robert Edward. Madison, Wis., Univ. of Wisconsin, 1966. 96p.

Thesis.

The elastic scattering of Σ^+ and Σ^- hyperons on protons in a hydrogen bubble chamber was studied. The hyperons were produced by interactions of K^- mesons of about 1.0 GeV/c momentum. A total of 18 Σ^+ and 22 Σ^- scatters is reported. The effective hyperon path length was 170 meters for Σ^+ and 415 meters for Σ^-. The incident hyperon momenta were in a range from 250 to 1350 MeV/c. Average elastic cross sections obtained were 45 ± 13 mb for Σ^+-p scattering, and 21 ± 6 mb for Σ^--p scattering. Mean Σ laboratory momenta were 680 MeV/c for Σ^+ and 785 MeV/c for Σ^-. A large forward-backward asymmetry is seen in the Σ^- cm scattering angle distribution, while the Σ^+ angular distribution is consistent with isotropy. Evidence is presented which indicates that the sign of the Σ^+ average polarization parameter in Σ^+-p scattering is positive. One example was found of each of the reactions $\Sigma^+ + p \rightarrow \Lambda + p + \pi^+$ and $\Sigma^- + p \rightarrow \Lambda + p + \pi^-$. Cross sections for these processes are estimated. (Dissertation Abstr.)

Strong (Meson-Induced)

Refer also to abstract 9701.

9707 (JINR-P2-3004) RASCHET PROTSESSA DVOINOI PEREZARYADKI π-MEZONOY NA YADRAKH. (Calculation of a Double Charge Exchange of π-Mesons by Nuclei). Batusov, Yu. A.; Kochkin, V. I.; Mal'tsev, V. M. (Joint Inst. for Nuclear Research, Dubna (USSR)). 1966. 13p. (In Russian). Dep. mn.

Using the cascade model for π-meson interaction by nucleus by the Monte-Carlo method the total cross sections are calculated for a double charge exchange of π-mesons by nuclei in the photoemulsion at different energies of primary mesons in the range of 50–300 MeV. The dependence of the cross section on the atomic number of the nucleus is obtained and the energy and angular distributions of secondary mesons are calculated. (auth)

9708 (JINR-P10-3032) METOD OBRABOTKI EKSPERIMENTAL'NYKH DANNYKH S POMOSHCH'YU SUPERPOZITSII NORMAL'NYKH ZAKONOV. (Method for Experimental Data Processing by Using Normal Law Superposition). Kosareva, A. M.; Ososkov, G. A.; Tolstov, K. D. (Joint Inst. for Nuclear Research, Dubna (USSR)). 1966. 13p. (In Russian). Dep. mn.

A method is given for experimental data processing taking account of measurements performed with different accuracy. Probability densities of components of a desired random variable are decomposed into a normal law superposition. The number of terms of decomposition and the density parameters are estimated by the least squares method. The above method is applied to the calculation of the probability density of the transverse momentum in inelastic π^--p collisions at 7 GeV/c. (auth)

9709 (JINR-P1-3088) ISSLEDOVANIE REAKTSII $\pi^- + p \rightarrow \pi^- + p + m\gamma$ ($m \geq 1$) PRI IMPUL'SE π^--MEZONOV 4 GeV/c. (Investigation of the Reaction $\pi^- + p \rightarrow \pi^- + p + m\gamma$ ($m \geq 1$) at a π^--Meson Momentum of 4 GeV/c). Lyubimov, V. B.; Streltsov, V. N. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of High Energy). 1966. 10p. (In Russian). Dep. mn.

Interactions, when, at least, one visible γ quantum is emitted, are investigated using the photographs from a 24-liter propane bubble chamber bombarded with the negative pions of (3.97 ± 0.06) GeV/c momentum. The results are given of the analysis of 498 two-prong events which have the secondary proton with the momentum (lcm) from 180 to 500 MeV/c. (auth)
(auth)

9710 STUDY OF π^+ 2 π^- FINAL STATES COHERENTLY PRODUCED ON NUCLEI BY 16 GeV/c π^-. Allard, J. F. (Faculte des Sciences, Orsay, France); Drijard, D.; Hennessy, J. (and others). Nuovo Cimento (10), 46A: 737-47(Dec. 21, 1966).

Coherent production of $\pi^+ 2\pi^-$ occurs in ~1% of 15 and 16 GeV/c π^- C_2F_5Cl interactions (studied in the Ecole Polytechnique HLBC exposed at CERN P.S.). For nearly every coherent event, one or both $\pi^+\pi^-$ combinations lies in the ρ^0 or f^0. The ratio of π^-f^0 to $\pi^-\rho^0$ coherent production is 0.05 ± 0.02. No A_1^* peaks are seen in the coherent events. The $\pi^-\rho^0$ mass distribution is dominated by a peak in the A_1 region but nearly 250 MeV wide. S-wave $\pi^-\rho^0$ ($J^P = 1^+$) dominates up to at least 1.2 GeV in $M_{\pi^-\rho^0}$ but small admixture of waves of opposite parity is necessary to explain some angular distribution asymmetries. The A_1 peak is too narrow to be explained by the momentum transfer limitation imposed by the nuclear form factor. The Dalitz plot excludes dominances of triangle singularity effects. The calculated OPE (Deck model) and ρ exchange $M_{\pi\rho}$ distributions are also too broad to fit the data, but

uncertainties in the model preclude its firm rejection. In the case of dominance of resonances in our data, it would be necessary to assume two other resonances in addition to A_2 to preserve an A_1 of width ≲150 MeV. (auth)

9711 THE POLARIZATION PARAMETER IN $\pi^\pm$p AND pp ELASTIC SCATTERING FROM 6 TO 12 GeV/c. Borghini, M.; Coignet, G.; Dick, L.; Kuroda, K.; Di Lella, L.; Macq, P. C.; Michalowicz, A.; Olivier, J. C. (CERN, Geneva). Phys. Lett., 24B: 77-80(Jan. 9, 1967).

Experimental results are given for the polarization parameter P_0 in π^-p scattering at 6.0, 8.0, 10.0 and 12.0 GeV/c, and in π^+p and pp scattering at 6.0, 10.0 and 12.0 GeV/c. The invariant four-momentum transfer squared $-t$ varies from 0.1 to 0.75 $(GeV/c)^2$. (auth)

9712 DECAY PROPERTIES OF THE $A_2(1310)$ MESON. Chung, Suh Urk; Dahl, Orin I.; Hardy, Lyndon M.; Hess, Richard I.; Kirz, Janos; Miller, Donald H. (Univ. of California, Berkeley). Phys. Rev. Lett., 18: 100-4(Jan. 16, 1967).

The properties of the A_2 enhancement are determined from the $K\bar{K}$ and $\pi\rho$ decay modes independently. The characteristics of both systems are consistent with the decay of a particle having $I^GJ^P = 1^-2^+$. (auth)

9713 SINGLE-PION PRODUCTION IN π^- + p COLLISIONS AT 2.14 GeV/c. Hagopian, Vasken (Univ. of Pennsylvania, Philadelphia. Univ. of California, Berkeley); Pan, Yu-Li. Contract W-7405-eng-48. Phys. Rev., 152: 1183-9(Dec. 23, 1966). (UCRL-16977).

A bubble-chamber experiment in which the reaction $\pi^- + p \rightarrow \pi + \pi + N$ was studied at a beam momentum of 2.14 GeV/c yielded 1533 and 2234 events of the final states $\pi^-\pi^0$p and $\pi^-\pi^+$n, respectively. These events are dominated by the formation of the ρ resonance, which is produced mostly in the forward direction. Both the production and decay angular distributions of the ρ^- agree very well with the predictions of the one-pion exchange theory modified by absorption effects. The decay angular distribution of the ρ^0 shows the well-known forward-backward asymmetry. This effect is interpretable as the result of the interference between the ρ^0 and an isospin-zero s-wave π-π resonance. The production of the ρ^0, in addition to its forward peak, shows a weak backward peak. Partial cross sections of various final states are also presented. (auth)

9714 STRANGE-PARTICLE PRODUCTION IN 7.91-GeV/c π^-p INTERACTIONS. Ehrlich, R.; Selove, W.; Yuta, H. (Univ. of Pennsylvania, Philadelphia). Phys. Rev., 152: 1194-8(Dec. 23, 1966).

Data on the production of resonances are given. Evidence for a possible $Y_1^*(3000)$ is found, along with observation of known resonant states. An indication is found for some $K\bar{K}$ decay of a recently reported dipion resonance at 1675 MeV. Cross sections were calculated for various final states. The two-body final state Λ^0K^0 was studied. (auth)

9715 OBSERVATION OF A BACKWARD PEAK IN THE REACTION $\pi^- + p \rightarrow Y^0 + K^0$ AT 6 GeV/c. Crennell, David J.; Kalbfleisch, George R.; Lai, Kwan Wu; Scarr, J. Michael; Schumann, Thomas G.; Skillicorn, Ian O.; Webster, Medford S. (Brookhaven National Lab., Upton, N. Y.). Phys. Rev. Lett., 18: 86-8(Jan. 16, 1967).

The observation of a backward peak in the Y^0K^0 final state at 6 GeV/c, where Y^0 is either Λ^0 or Σ^0, from the reaction $\pi^- + p \rightarrow Y^0 + K^0$ is reported. The slope of this backward peak is fitted by $\exp[\gamma_b(\mu - \mu_0)]$, and a value of $\gamma_b = 5.7 \pm 2$ GeV^{-2} is obtained, where μ is the square of the four-momentum transfer in the appropriate crossed channels and μ_0 is the kinematic maximum value of μ. Also found is a value of the slope for the forward peak, $\gamma_f = 7.8 \pm 0.5$ GeV^{-2}, from an $\exp[\gamma_f(t - t_0)]$ fit, where t is the square of the four-momentum transfer for the direct channel and t_0 is the kinematic maximum value of t. (J.F.P.)

9716 PRODUCTION OF Λ-HYPERONS IN K^- INTERACTIONS AT REST IN CF_3Br. Buran, T.; Frodesen, A. G.; Skjeggestad, O.; Toefte, H.; Vegge, I. (Oslo Univ.). Nucl. Phys., 87: 532-48(1966).

An investigation was made of Λ hyperons produced by about 39,000 K^- mesons stopping in a bubble chamber filled with CF_3Br. Approximately 1600 Λ hyperons decaying by the charged mode were measured. From a comparison of the momentum spectra of Λ hyperons originating in various types of K^- interactions, the percentage of Λ hyperons produced in K^- captures on more than one nucleon is estimated to lie between (22 ± 4) and (40 ± 3)%. Observed momentum and angular distributions are compared with expectations for different reactions as calculated from an optical model. The amplitude for direct Λ production in K^- captures on pairs of protons is shown to be small, and it is likely that most Λ hyperons from multi-nucleon K^- captures are indirectly produced. The total emission rate of Λ hyperons from K^- interactions at rest in CF_3Br is (60 ± 3)%. (auth)

9717 STUDY OF $\pi^- + p \rightarrow \Sigma^0 + K^0$ AT 1170 MeV/c. Anderson, Jared A.; Crawford, Frank S. Jr.; Doyle, Joseph C. (Univ. of California, Berkeley). Contract W-7405-eng-48. Phys. Rev., 152: 1139-48(Dec. 23, 1966). (UCRL-16861).

The differential and total cross sections and polarization of the Σ^0 from the reaction $\pi^- + p \rightarrow \Sigma^0 + K^0$ with 1170-MeV/c pions incident on the Alvarez 72-in. hydrogen bubble chamber were measured. Using 524 single-Λ events (where the only visible decay is that of the Λ from the decay $\Sigma^0 \rightarrow \Lambda + \gamma$), 138 single-$K^0$ events (where only the K^0 decay is visible), and 256 double-vee events (where both Λ and K^0 decays are visible), the coefficients in the Legendre expansion of the differential cross section $d\sigma/d\Omega = A_0P_0 + A_1P_1 + A_2P_2$ are found to be $A_0 = 19.68 \pm 0.60$ μb/sr, $A_1 = -0.04 \pm 1.20$ μb/sr, and $A_2 = 14.54 \pm 1.60$ μb/sr, corresponding to a total cross section $\sigma = 247 \pm 10$ μb. No polynomials higher than P_2 are needed. Using both single-Λ and double-vee events, the coefficients in the polarization expansion $P_\Sigma d\sigma/d\Omega = \frac{1}{2} \sin\theta_\Sigma (B_1 + B_2 \cos\theta_\Sigma)$ are found to be $B_1 = -9.98 \pm 8.29$ μb/sr and $B_2 = -35.45 \pm 21.88$ μb/sr. In both angular-distribution and polarization studies a single-Λ event is statistically equivalent to about one half of a double-vee event. (auth)

9718 REACTIONS $K^-p \rightarrow$ HYPERON + MESON AT 3.5 GeV/c. Phys. Rev., 152: 1148-61(Dec. 23, 1966).

A study was made of some of the quasi-two-body final states (in which one of the particles is a hyperon) produced by 3.5-GeV/c K^- mesons on protons. The analysis was performed with 310,000 photographs taken in the 81-cm Saclay hydrogen bubble chamber. The cross sections for most of the reactions are lower than have been observed at lower incident momenta. Many of the reactions are characterized by a forward peaking of the production angular distribution of the final-state meson, but in a few cases a significant backward peak was observed. Decay distributions of unstable particles were investigated to obtain more information about the production processes. The Y_1^{*+} (1385) decay is consistent with the $Y^{*+}\pi^-$ final state being produced by K^* exchange, but in the case of the production of vector mesons, it is difficult to draw any conclusion concerning the spin of the exchanged particle. An enhancement was observed at 1645 MeV in the $\Sigma^+\pi^+$ system. It is difficult to interpret this in terms of the decay of the neutral Y_1^* (1660). (auth)

9719 LARGE-ANGLE PION–PROTON ELASTIC SCATTERING AT HIGH ENERGIES. Orear, J. (Cornell Univ., Ithaca, N. Y.); Rubinstein, R.; Scarl, D. B.; White, D. H.; Krisch, A. D.; Frisken, W. R.; Read, A. L.; Ruderman, H. Phys. Rev., 152: 1162-70(Dec. 23, 1966).

Differential cross sections for elastic $\pi^\pm$-p scattering were measured at lab momenta of 8 and 12 GeV/c in a momentum-transfer region corresponding to $1.2 \leq -t \leq 6$ $(GeV/c)^2$. Also, differential cross sections near 180° were measured for 4 and 8 GeV/c pions. At momentum transfers greater than $-t = 2$ $(GeV/c)^2$, the π-p cross sections drop much faster with increasing angle than the corresponding p-p cross sections. Also, in the region $-t \approx 1.3$ $(GeV/c)^2$, there is structure in the π-p angular distribution but not in the p-p angular distribution. At $-t \approx 3$ $(GeV/c)^2$, the drop in cross section appears to stop and from then on the angular distribution is consistent with isotropy. But in the angular region 170 to 180°, the cross sections have become much larger, and sharp backward peaks are observed. Information is given on the energy and charge dependences and widths of these backward peaks. (auth)

9720 STRUCTURE IN THE K^--NUCLEON TOTAL CROSS SECTIONS BETWEEN 600 AND 1400 MeV/c. Davies, J. D. (Univ. of Birmingham, Eng.); Dowell, J. D.; Hattersley, P. M.; (and others). Phys. Rev. Lett., 18: 62-4(Jan. 9, 1967).

The K^-p and K^-d total cross sections were measured between 600 and 1400 MeV/c at intervals of about 25 MeV/c, with a statistical accuracy typically of ±0.3 mb and with a momentum resolution of ±0.6%. In addition to the well-known resonances, a Y_0^* resonance with a mass of 1698 ± 5 MeV/c^2 is observed, and evidence is found for a Y_1^* (1905), confirming an observation by Cool et al. (Phys. Rev. Letters 16: 1228(1966)). (B.G.D.)

9721 PION-PION INTERACTIONS IN $\pi^-\rho$ REACTIONS AT 2.1 BeV/c. West, Edmund Cary Jr. Madison, Wis., Univ. of Wisconsin, 1966. 144p.

Thesis.

An analysis is given of the interactions of two pions as they result from the reactions of negative pions incident upon protons with a momentum of 2.1 BeV/c. A historical background of the motivation for the experiment is given and experimental techniques for dealing with the data are described, both from the point

of view of event-by-event analysis and the physical theories which aid in the understanding of the results. Cross sections are given for the various reactions and are inferred by Chew-Low methods for pion-pion scattering. Evidence is presented which indicates that two resonant states in addition to the ρ-meson are present in these reactions: the N^*_δ (1920) whose existence in other reactions is well established, and the T = 0, s-wave, pion-pion interaction which is still in doubt, known as the ϵ^0, the evidence for which stems from an analysis of the decay distribution of the ρ^0. Finally, corrections to the One Pion Exchange model which involve pion-nucleon scattering vertices are made in an attempt to determine more accurately the low energy, s-wave, pion-pion scattering cross sections, the results suggesting a range of about 10-15 mb in the region below the ρ. (Dissertation Abstr.)

Particle Interactions and Properties (Theoretical)

General

Refer also to abstracts 10088 and 10107.

9722 STATISTICAL SCATTERING AND THE OREAR FORMULA. Sisakyan, I. N.; Feinberg, E. L.; Chernavskii, D. S. (Lebedev Inst. of Physics, Moscow). JETP Lett. (USSR) (Engl. Transl.), 4: 290-3(Nov. 15, 1966).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Redaktsiyu, 4: 432-6(Nov. 15, 1966).

It is found that the universal Orear formula can be interpreted as the result of a combination of the statistical scattering and diffraction due to all statistical processes. Also since large-angle elastic scattering is governed, in general, not only by statistical scattering but also by diffraction statistical scattering, it follows that elastic $p\bar{p}$ scattering at low energies is asymmetrical about 90°, in agreement with experiment. The appearance of symmetry is expected when the angle, at which the differential and statistical scatterings are equal, becomes smaller than 90° with increasing energy. (J.F.P.)

9723 RELATIVISTIC QUANTUM THEORY OF INTRINSIC MASSES. Fujiwara, I. (Norwegian Inst. of Tech., Trondheim). Ark. Fys. Seminar Trondheim, No. 7, 1-59(1966).

Correspondence arguments are developed to establish a set of nonlinear integro-differential equations for noncausal fermion and boson propagators. The fundamental length λ is defined as half of the classical radius of the electron, to which order the microcausality is proposed to be renounced in the description of subnuclear phenomena. The micro-noncausality originates from the fact that the effects of the interaction are taken into account by fundamental relativistic equations from the very beginning. They are nothing but nonlinear eigenvalue equations to fix intrinsic masses of fundamental particles in terms of the fundamental length and the interaction strength. The physical masses of electron and nucleon are thus regarded as purely of electromagnetic and mesic origins respectively, and the value of the electron-nucleon mass ratio can be understood semiquantitatively. The relation of the present theory to orthodox theory of quantized field, Yukawa's nonlocal theory, and Heisenberg's nonlinear theory are discussed. Finally future prospects of the theory are stated, especially in relation to the problem of the internal symmetry of fundamental particles. (auth)

9724 ON THE RELEVANCY OF THE SINGULARITIES OF THE FUNCTIONS ASSOCIATED WITH THE FEYNMAN GRAPHS. Andersson, Bo (Univ. of Lund, Sweden). Nucl. Phys., 87: 501-31(1966).

A method to determine the relevancy of the singularities associated with the Feynman graphs is presented and applied to an example. (auth)

9725 THREE-BODY UNITARITY AND KHURI-TREIMAN AMPLITUDES. Aitchison, I. J. R. (Cambridge Univ., Eng.); Pasquier, R. Phys. Rev., 152: 1274-85(Dec. 23, 1966).

The s-wave Khuri-Treiman (K-T) amplitude for three-body production or decay processes with final-state interactions satisfies a linear single-variable integral equation. The inhomogeneous term is the Watson final-state enhancement factor (or isobar term), while the integral part represents rescattering corrections. It is proved that the presence of this term guarantees that the amplitude satisfies a form of three-body unitarity, in which the three bodies interact in pairs only. This means that two-body unitarity, analyticity, and crossing have generated three-body unitarity (and a three-body amplitude). If the result can be generalized to higher partial waves, it suggests that one can unitarize (in this sense) any inhomogeneous term, provided it has no three-body branch point itself, by simply adding on the integral term, a procedure which could be applied, for instance, to the isobar, peripheral, or stripping models. This is by way of alternative to the usual N/D method in the three-body channel, and seems to imply equations a good deal easier to handle numerically. A comparison between the unitarity relation obtained from the K-T equation and the one normally assumed discloses a difference between them, which would be important if one wished to consider continuations of the relation in the three-body mass. (auth)

9726 PARTICLES AND SOURCES. Schwinger, Julian (Harvard Univ., Cambridge, Mass.). Contract AF 49(638)-1380. Phys. Rev., 152: 1219-26(Dec. 23, 1966).

It is proposed that the phenomenological theory of particles be based on the source concept, which is abstracted from the physical possibility of creating or annihilating any particle in a suitable collision. The source representation displays both the momentum and the space-time characteristics of particle behavior. Topics discussed include: spin and statistics, charge and the Euclidean postulate, massless particles, and SU_3 and spin. It is emphasized that the source description is logically independent of hypotheses concerning the fundamental nature of particles. (auth)

9727 SPIN-MATRIX POLYNOMIAL DEVELOPMENT OF THE HAMILTONIAN FOR A FREE PARTICLE OF ARBITRARY SPIN AND MASS. Williams, S. A.; Draayer, J. P.; Weber, T. A. (Ames Lab., Ames, Iowa). Contract W-7405-eng-42. Phys. Rev., 152: 1207-12(Dec. 23, 1966). (IS-1403).

The Hamiltonian and other relevant physical operators for a free particle of arbitrary spin and mass, based upon the generalized Foldy-Wouthuysen transformation, are developed in terms of the spin-matrix polynomials. The general theory of these polynomials, given in an earlier paper, is reviewed briefly. It is a general feature of these expansions that the number of terms is determined by the spin of the particle, but the coefficients are spin-independent. The massless limit is examined in some detail and the invariant metric operator is discussed. (auth)

9728 RENORMALIZATION CONSTANTS IN THE EXTENDED LEE MODEL ($W \simeq V + \theta$). Chen, Fei S. (Carnegie Inst. of Tech., Pittsburgh). Phys. Rev., 152: 1408-10(Dec. 23, 1966).

The Lee model is extended to include a W field with an interaction $W \simeq V + \theta$. By Green's-function techniques the model is still found to be exactly solvable in the $V\theta$ and $N\theta$ sectors; however, only closed forms of the W propagator and the $WV\theta$ vertex function are presented. The wave-function renormalization and the vertex-function renormalization are derived; they are not equivalent to each other, while in the Lee model they are equal. (auth)

9729 THERMODYNAMIC EQUILIBRIUM OF ELEMENTARY PARTICLES AT HIGH TEMPERATURES. Borla, V.; Ferrari, A.; Wataghin, G. (Univ., Turin). Nuovo Cimento (10), 46A: 778-85 (Dec. 21, 1966).

An approximate treatment of statistical equilibrium is considered for the processes of creation and annihilation of particles in high-energy collisions and in decays of unstable particles. Special attention is given to temperatures $kT^* \simeq mc^2$, where m is one of the largest masses of the particles constituting the assembly. (L.B.S.)

9730 NONPERTURBATIVE SOLUTIONS OF THE BETHE–SALPETER EQUATION FOR THE VERTEX FUNCTION. Jackiw, Roman Wladimir. Ithaca, N. Y., Cornell Univ., 1966. 119p.

Thesis.

For the purpose of developing techniques for studying the high energy behavior of a field theoretic n-point function, a study is undertaken of the three-point (vertex) function. A Bethe–Salpeter equation for the vertex is derived. Asymptotic solutions for the spinor electrodynamic vertex, both on and off the mass shell, in the ladder approximation are found under the condition that the momentum transfer is large and space-like. Corrections to the ladder approximation are discussed, and the effect of all the crossed diagrams is studied. A similar calculation is performed for the vertex of scalar electrodynamics at zero momentum transfer. It is found that although perturbation theory diverges in every order, an exact finite solution exists which is not analytic in the coupling constant. (Dissertation Abstr.)

Electromagnetic

Refer also to abstract 9768.

9731 (JINR-P2-3028) DISPERSIONNYE PRAVILA SUMM V KOMPTONOVSKOM RASSEYANII NA BARIONAKH. (Dispersion Sum Rules in the Compton Scattering by Baryons). Aznauryan, I. G. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1966. 10p. (In Russian). Dep. mn.

Sum rules for the photon-baryon scattering are obtained from the ordinary one-dimensional dispersion relations. From these sum rules the relations follow between the baryon magnetic moments and the radiative decay magnetic moments of the nearest resonances which are in good agreement with experiment and the SU(6) symmetry predictions. (auth)

9732 (JINR-P2-3067) NARUSHENIE CP-INVARIANTNOSTI V SLABOELEKTROMAGNITNYKH VZAIMODEISTVIYAKH I RASPAD $K_L \to \pi^+\pi^-$. (CP-Violation in Weak Electromagnetic Interactions and $K_L \to \pi^+\pi^-$-Decay). Arbuzov, B. A.; Filippov, A. T. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1966. 5p. (In Russian). Dep. mn.

P-invariant modification of the previously proposed CP-violating mechanism in coupling of spinor particles with photons is considered. The interaction may occur on the electromagnetic or weak-electromagnetic level. It is shown that in the latter case the parameters of nonradiative decays in the $K^0-\overline{K}^0$ system are the same as the ones in the model of superweak CP-violating interaction. (auth)

9733 SOME ELECTROMAGNETIC PROCESSES ON NUCLEI AT HIGH ENERGIES. Rekalov, M. P. Ukr. Fiz. Zh., 11: 1286-95(1966). (In Ukrainian).

Peripheral mechanisms for various electromagnetic processes on nuclei are investigated: photoproduction of vector mesons on deuterons, scattering of γ quanta on deuterons, photoproduction of π^0 mesons on deuterons and ^{4}He nuclei. During calculations the contribution of the lowest as to mass permitted meson state in the annihilation channel is preserved: for the processes of γ quanta scattering on deuterons and photoproduction of vector mesons only exchange by the η meson is taken into account; for processes of photoproduction of π^0 mesons on α and ^{4}He, exchange by the ω meson is taken into account. In the polar approximation the differential and complete sections of the examined processes are calculated without regard for interaction in final state. In all cases a great increase of sections with the energy is observed because of the large values of the spins of the particles participating in the reactions. The possibilities of determining the constants of radiation meson decays on the basis of the investigated processes are discussed in detail. It is noted that it is possible to distinguish the peripheral mechanisms of the investigated reactions in experiments with linearly polarized γ quanta. The density matrix of the ρ^0 meson is obtained for the process $\gamma + \alpha \to \alpha + \rho^0$. The angular and energetic distributions of π mesons of the $\rho \to 2\pi$ decay are calculated with the help of this matrix. (auth)

9734 FLUX AND ENERGY SPECTRUM OF SECONDARY ELECTRONS IN THE UPPER ATMOSPHERE. Perola, G. C.; Scarsi, L. (Univ., Milan. CNR, Milan). Nuovo Cimento (10), 46A: 718-36(Dec. 21, 1966).

Detailed calculations have been made on the vertical flux and energy spectra of the secondary γ-rays and electrons in the upper atmosphere. The results given refer to the atmospheric depth of 1 g/cm^2 for γ rays and of 2, 4, 6 g/cm^2 for electrons, at the geomagnetic vertical cutoff rigidity of 0.5, 2, 4.5, 10, 16 GeV at solar minimum. The processes taken in consideration are the $\pi^0 \to \gamma + \gamma$ decay, the chain $\pi^\pm \to \mu^\pm \to e^\pm$ and the $\gamma \to e^+ + e^-$ conversion. The calculations have been based on a pion-source spectrum obtained using accelerator data on the basic nuclear interaction, from the production threshold up to 30 GeV energy for incident protons. The precision on the numerical values obtained is estimated at better then 2%, for γ-ray and electron energies up to few GeV; the indetermination derives from the errors in the data on the nuclear interactions and from the approximation introduced on the angular spread of the secondary particles. The data obtained are used for estimating the contribution of secondary electrons and γ-rays to the total flux observed in the upper atmosphere with balloon experiments. (auth)

9735 CURRENT COMMUTATOR AND THE $I^*(1236)$. Alam, M. A. (Univ. of Durham, Eng.). Nuovo Cimento (10), 46A: 752-9(Dec. 21, 1966).

The equal-time commutator of axial vector charges and the isovector electromagnetic current are considered. The matrix element of the commutation relation is taken between an isobar $N_{33}(1236)$ and the nucleon $N_{11}(938)$, and an analysis is carried out, saturating the commutator by a nucleon and a $N_{33}(1236)$. Results are obtained for the coupling constant for the $N_{33}^+N_{33}^+\pi^0$ vertex and the magnetic dipole moment of N_{33}^+ which are in disagreement with SU_6 predictions. (L.B.S.)

9736 ON THE NONLINEAR EFFECTS IN QUANTUM ELECTRODYNAMICS: THE COALASCENCE OF PHOTONS IN A NUCLEAR COULOMB FIELD. Costantini, V. (Univ., Rome); Pistoni, G.; De Tollis, B. Nuovo Cimento (10), 46A: 684-9(Dec. 21, 1966).

The coalescence of two photons into one in a nuclear electric field, at lowest perturbative order, is evaluated in the case where the incoming photons are collinear and monochromatic. This particular kinematics simplifies considerably both the calculations (carried out with the aid of usual Feynman–Dyson techniques) and the results. In particular no higher transcendental function, such as the dilogarithm function, appears. The rate for the reaction is evaluated in a closed form and some curves are given. (auth)

9737 HIGH-ENERGY PHOTOPRODUCTION OF VECTOR MESONS AND REGGE POLES. Buccella, F.; Colocci, M. (Univ., Florence). Phys. Lett., 24B: 61-3(Jan. 9, 1967).

A Regge pole analysis of the photoproduction of neutral vector mesons under the hypothesis that the interaction $\gamma +$ hadrons are dominated by vector mesons (the Sakurai universality hypothesis) is presented. Assuming SU(3) and pure F-type coupling between baryons and the octet of even intrinsic-parity trajectories with $J = 2^+$ and signature, and $\alpha_{Pom}(t = 0) = 1$ and $\alpha_{S_0}(t = 0) = \frac{1}{2}$, three inequalities for the differential cross sections and a quadratic relation between the differential cross sections are derived. (J.F.P.)

9738 COULOMB ENERGY AND THE MASS DIFFERENCE OF ^{3}H AND ^{3}He. Gupta, V. K. (Univ., Delhi); Mitra, A. N. Phys. Lett., 24B: 27-9(Jan. 9, 1967).

The calculated Coulomb energy is large enough to account for the mass difference of ^{3}H and ^{3}He. (auth)

9739 QUANTUM-RELATIVISTIC CONCEPT OF THE PHOTON. Sofonea, Liviu (Polytechnic Inst., Brasov, Rumania). Stud. Cercet. Mat., 18: 1371-1404(1966). (In Rumanian).

On the basis of a historical perspective, the correlation between the photon and the wave function was examined, starting with the classical case, in which the photon is identified by relativistic Maxwell equations, serving as the field equations. The introduction and description of the quantum state values, such as the impulse energy, kinetic momentum, polarization and parity properties were studied, relating the findings to a photon system possessing a field resulting from a second quantization. The corpuscular properties of light served as the starting point for the development of the quantum theory, offering the first example of the dual aspects of physical objects and representing a fusion of the continuous and discontinuous facets. The relation between the energy of the light particle, the photon, and the oscillation of the corresponding electromagnetic field ($\omega = 2\pi$) represents the first physical law containing Planck's constant. The development of the concept of the photon was followed through Schrödinger's equations. The probable character of the wave function was emphasized in the treatment, in which the transformation, annihilation and generation of photons were discussed; their relativistic nature results in a variable number of particles when examining a system of photons in a continual energy exchange with the charges. (TTT)

9740 MINIMAL ELECTROMAGNETIC CURRENTS AND COMMUTATION RELATIONS. Kawarabayashi, Ken; Suzuki, Mahiko (California Inst. of Tech., Pasadena). Contract AT(11-1)-68. Phys. Rev., 152: 1383-4(Dec. 23, 1966). (CALT-68-90).

It is pointed out that within the quark model and equal-time commutation relations of currents provide us with a test of minimal electromagnetic interaction of the hadrons. When compared with experiment, the modifications of the Cabibbo-Radicati and Drell-Hearn sum rules resulting from nonminimal interactions may possibly fix the isoscalar and the isovector Pauli interactions. (auth)

9741 CHIRAL ALGEBRA, CONFIGURATION MIXING, MAGNETIC MOMENTS, AND PION PHOTOPRODUCTION. Gerstein, I. S.; Lee, B. W. (Univ. of Pennsylvania, Philadelphia). Contract AT(30-1)-2171. Phys. Rev., 152: 1418-28(Dec. 23, 1966). (NYO-2171-206).

A model is developed for baryon states as a mixture of representations of the chiral SU (3) ⊗ SU (3) algebra generated by the time components of vector and axial-vector currents. The model predicts a sum rule $G_A = 1 + \frac{1}{4} G^{*2}$, where G_A is the axial-vector coupling constant of the nucleon and G^* is the nucleon-(3,3)- resonance matrix element of the axial current. It is shown how to derive G^* from experiment, and using this information $G_A = 1.25$. Using the electric dipole operator it is found that the magnetic moment of the nucleons is pure isovector, as is the photoproduction amplitude of the isospin-$\frac{1}{2}$ pion-nucleon resonances from nucleons. A value for the magnetic dipole transition from the nucleon to the (3,3) resonance is found, which also agrees with experiment. (auth)

9742 PHOTONIC DECAY RATES AND NUCLEAR-COULOMB-FIELD COHERENT PRODUCTION PROCESSES. Halprin, A. (Univ. of Delaware, Newark); Andersen, C. M.; Primakoff, H. Phys. Rev., 152: 1295-1303(Dec. 23, 1966).

The relationship between the $A \to B + \gamma$ photonic decay process

and the "inverse" nuclear-Coulomb-field coherent production process $B + Z \rightarrow B + \gamma' + Z \rightarrow A + Z$ [Z ≡ high-Z nucleus, γ' ≡ exchanged virtual Coulomb photon] is studied in some detail for arbitrary particles (A,B). A procedure is described for the determination of the rate of $A \rightarrow B + \gamma$ from measurement of the differential cross section for A-particle coherent production by a B particle incident on a high-Z nucleus. A numerical application of the formulas derived is worked out in the case $K^- + Z \rightarrow K^{*-} + Z$, and it is estimated that a K^- energy in the range 3–15 BeV is required for a successful determination of the rate of $K^{*-} \rightarrow K^- + \gamma$. (auth)

9743 EXACT SUM RULES AS CONSEQUENCES OF LOW-ENERGY THEOREMS AND UNSUBTRACTED DISPERSION RELATIONS. Kawarabayashi, Ken (California Inst. of Tech., Pasadena); Wada, Walter W. Contracts AT(11-1)-1545; AT(11-1)-68. Phys. Rev., 152: 1286-90(Dec. 23, 1966). (CALT-68-89).

Working with the equal-time commutation relations of vector current densities including the Schwinger term, the low-energy theorems for the Compton scattering of isovector photons by nucleons were obtained. Assuming unsubtracted dispersion relations, sum rules which have been previously obtained by several authors were reproduced and the relations between the previous derivations and the present work are discussed. (auth)

9744 SIMPLE RELATIVISTIC CALCULATION OF THE ELECTROMAGNETIC FORM FACTORS OF THE DEUTERON. Dietz, Klaus; Month, Melvin (Univ. of Illinois, Urbana). Contract NONR 1834(05). Phys. Rev., 152: 1364-74(Dec. 23, 1966).

A simple method of extracting anomalous singularities from the electromagnetic vertex function of bound states is proposed. The method was applied to the electromagnetic form factors of the deuteron and its relevance was proven by a thorough comparison with the experimental data. (auth)

9745 THEORY OF PROTON–PROTON BREMSSTRAHLUNG. Cromer, A. H. (Northeastern Univ., Boston); Sobel, M. I. Phys. Rev., 152: 1351-6(Dec. 23, 1966).

The proton-proton bremsstrahlung cross section is derived to first order in the electromagnetic interaction and the nucleon-nucleon t matrix. The cross section is expressed in terms of the nucleon-nucleon phase shifts and the quasi-phase parameters needed to describe t off the energy shell. The formulas are given in a form suitable for calculation. (auth)

9746 POSSIBILITY OF OBTAINING COMPLEX FORM FACTORS FROM EXPERIMENTS WITH POLARIZED PARTICLES. Sokolov, A. A.; Kerimov, B. K.; Jafarov, I. G.; Yakhyaev, R. Sh. (Moscow State Univ.). Ann. Phys. (7), 18: 101-2(1966).

A possibility of determining nucleon complex electromagnetic form factors by means of measurements of polarizations of minimal permissible number of particles is considered in the reactions $\tilde{p} + p \rightarrow \bar{l} + l$ and $\bar{l} + l \rightarrow \tilde{p} + p$. (auth)

9747 PARTIALLY CONSERVED AXIAL-VECTOR CURRENT RESTRICTIONS ON PION PHOTOPRODUCTION AND ELECTROPRODUCTION AMPLITUDES. Adler, Stephen L. (Harvard Univ., Cambridge, Mass.); Gilman, Frederick J. Phys. Rev., 152: 1460-7(Dec. 23, 1966).

The restrictions imposed by the partially conserved axial-vector current (PCAC) on the pion photoproduction amplitude $V_1^{(+)}(0)$ and on the pion electroproduction amplitude $V_\theta^{(-)}(0)$ are discussed. It is found that the magnetic-dipole dominance and the narrow-resonance approximations are unreliable. The nonresonant s waves make an important contribution to $V_1^{(+)}(0)$, and it is found that the PCAC prediction for this amplitude is reasonably well satisfied. The electric and longitudinal multipoles appear to make a much bigger contribution to $V_\theta^{(-)}(0)$ than does the magnetic dipole M_{1+}, which is strongly suppressed by the kinematics. (auth)

9748 FEEDBACK MECHANISM FOR THE n-p MASS DIFFERENCE. Fried, H. M.; Truong, T. N. (Brown Univ., Providence). Phys. Rev., 152: 1467-70(Dec. 23, 1966).

A feedback mechanism which can yield the correct sign for the n-p mass difference is described in detail, and is shown to have its origin in the inelastic part of the Compton-amplitude contribution to the mass shift. (auth)

9749 CONSERVATION LAW IN ELECTROMAGNETIC THEORY. Dzhrbashyan, V. A. (Inst. of Physics, State Atomic Energy Commission, USSR). Dokl. Akad. Nauk Arm. SSR, 42: 101-5(1966). (In Russian).

All conservation laws related to the energy-momentum tensor and described by a complete heterogeneous Lorentz group were developed for the interacting magnetic field. It was found that these laws can be expressed by the momentum operators $p_\alpha(\mu)$ and generalized momenta $M_{\alpha\alpha}[Z,(\partial/\partial\mu)]$. Using an example of one class of conservation laws their physical concept is investigated by means of second-order quantization formulation. For a free field these laws are equivalent to a time quantum number for populating each photon level. (R.V.J.)

9750 SUPERCONVERGENT DISPERSION RELATIONS AND ELECTROMAGNETIC MASS DIFFERENCES. Harari, Haim (Stanford Univ., Calif.). Phys. Rev. Lett., 17: 1303-6(Dec. 26, 1966). (SLAC-PUB-241).

Using dispersion relations and the convergence properties of t-channel isospin amplitudes, it is shown that ΔI = 2 electromagnetic mass differences should be correctly obtained by summing the self-energy contributions of a few low-lying states; ΔI = 1 mass differences cannot be obtained in this way, and a subtraction term is always necessary; and the subtraction term has the correct sign for explaining the proton-neutron mass difference. (auth)

9751 LOW-ENERGY PHOTOPION PRODUCTION SU(6) AND THE PANOFSKY RATIO. Donnachie, A. (CERN, Geneva); Shaw, G. Nucl. Phys., 87: 556-70(1966).

It is argued that the main sources of uncertainty in low-energy photopion production occur in the multipoles $M_1^{(1)} + 3M_1^{(0)}$, $E_{1+}^{(3)}$, $E_{0+}^{(1)} + 3E_{0+}^{(0)}$ and $E_{0+}^{(3)}$. Parametric forms based on general assumptions are devised for these multipoles and a satisfactory fit is obtained to all the data up to $E_\gamma^{lab} = 440$ MeV. The lack of good π^0 data outside the threshold region is stressed and the multipoles compared to various theoretical predictions. In particular, the results for $E_{1+}^{(3)}$ favor the solution of Finkler compared to that of Rollnik et al., and good agreement is found with the prediction of SU(6) and other symmetries at resonance. However, the latter are less successful with the magnetic transition $M_{1+}^{(3)}$. Finally a careful analysis of the threshold region for π^+ production is carried out, and the Panofsky ratio problem reconsidered. The scattering length combination $\alpha_1 - \alpha_3 = 0.254 \pm 0.013$ is found, and this is compared with the results obtained by other methods. (auth)

9752 INVESTIGATIONS IN THE DISPERSION THEORETIC PERTURBATION SERIES. Abarbanel, Henry Don Isaac. Princeton, N. J., Princeton Univ., 1966. 62p.

Thesis.

Dispersion theoretic perturbation techniques originally developed by Dashen and Frautschi for the discussion of electromagnetic corrections to the strong interactions are used in non-strong interaction problems. The perturbation series is reviewed and extended, then three examples are discussed: the exponential potential perturbed by changing the coupling constant, a Lee model augmented in a manner resembling the calculations of Dashen and Gilman of baryon electromagnetic mass differences, and the Lamb shift. In the first example the use of the Born approximation in evaluating left hand cut discontinuities can lead to serious errors in determining shifts in bound state energies. In the second example the first order formula of Dashen and Frautschi can reproduce the field theoretic answer, if, and only if, self-energy contributions alone are used to evaluate shifts in the pole position of a scattering amplitude. In the final example it is indicated how to evaluate the Lamb shift to any order in the binding strength of the Coulomb potential ($Z\alpha$) and the perturbation by the radiation field (α). All infrared divergences arising from the Coulomb potential are shown to cancel in a straightforward manner. All infrared divergences of the perturbation are handled in a dispersion theoretic manner. Explicit formulas are given for the lowest order, $\alpha(Z\alpha)^4 m_e$, Lamb shift. A real numerical evaluation of this shift is not possible because of divergences indicated in the text; however, some fairly simple numerical estimates are made which indicate that the formulas derived in the text give the correct sign and order of magnitude of the level shift. Defects and virtues of the dispersion perturbation formulas are discussed. Finally a summary of the thesis is given followed by the possible treatment of the hyperfine structure of hydrogen by the same techniques. (Dissertation Abstr.)

Weak

Refer also to abstracts 9732 and 9782.

9753 NEUTRINO SCATTERING ON ELECTRONS IN W-MESON THEORY. Pavlenko, Yu. G.; Ivanov, Yu. P. (Moscow State Univ.). Izv. Vyssh. Ucheb. Zaved., Fiz., No. 1, 81-4(1966). (In Russian).

The matrix element of νe scattering due to exchange with a W-meson is written with four-momenta for the incident and scattered neutrino and electron with the use of first-order perturbation theory. An expression is derived for the differential scattering cross-section on a nonpolarized electron, and the total cross section is obtained by integrating. The νe scattering is also considered with the use of damping theory. In solving the equations of damping

theory, the amplitudes are broken down according to the Wigner d-functions, and an expression is obtained for the total elastic scattering cross section of a right or left neutrino on a nonpolarized electron. (TTT)

9754 THEORY OF THE UNIVERSAL WEAK INTERACTIONS AND THE INTERMEDIATE BOSONS. Kushtan, V. I. (Moscow State Univ.). Izv. Vyssh. Ucheb. Zaved., Fiz., No. 2, 128-32 (1966). (In Russian).

The experimental facts of universal weak interactions can be qualitatively explained by describing the baryon flux with the Sakata model. Then j^0_w = pn and j^1_w = pΛ. The vector flux is conserved, and the selection rules for nonleptonic decays with a change in strangeness are retained with $\Delta Q = \Delta S$, $|\Delta T| = \frac{1}{2}$ and $\Delta S = 1$. Neutral baryons are excluded. At energies of 10^3 BeV the interaction is nonlocal, and the existence of an intermediate W boson is postulated. Since j_w is represented as the sum of vector and pseudovector parts with conservation of the vector flux, the W meson should have a spin of 1. Its electric charge is also equal to 1. At present it was found that particles analogous to W do not exist up to energies of 1.3 BeV. It is difficult to observe the formation of W particles. It is necessary to detect characteristic μ^- and μ^+ pairs to prove their existence. A scheme of weak interactions with two intermediate bosons indicates that nonleptonic processes with a change in strangeness should be suppressed in comparison with corresponding processes where there is no change in strangeness. (TTT)

9755 COVARIANT EVALUATION OF K_1^0–K_2^0 MASS DIFFERENCE. Auvil, P. R.; Deshpande, N. G. (Northwestern Univ., Evanston, Ill.). Nuovo Cimento (10), 46A: 766-9(Dec. 21, 1966).

A complementary derivation is presented of a previous calculation of the $K_1^0 - K_2^0$ mass difference using the techniques of current algebra and assuming a specific form for the nonleptonic weak interaction. The expansion in $(M_K^2 - M_\pi^2)$ which was previously employed is avoided by considering the covariant expression for $(\delta M)^2$ in the infinite momentum plane. The need for a specific model of the weak Hamiltonian is also partially eliminated by further use of the current algebra. (L.B.S.)

9756 ON THE DIRECT DECAYS $K^\pm \to \pi^\pm + \gamma + \gamma$, $K^\pm \to \pi^\pm + \gamma + e^+ + e^-$, AND $K^\pm \to \pi^\pm + e^+ + e^-$. Lapidus, I. R. (Stevens Inst. of Tech., Hoboken, N. J.). Nuovo Cimento (10), 46A: 668-83 (Dec. 21, 1966).

The decay rates for $K^\pm \to \pi^\pm + \gamma + \gamma$, $K^\pm \to \pi^\pm + \gamma + e^+ + e^-$ and $K^\pm \to \pi^\pm + e^+ + e^-$ are discussed in terms of a virtual π^0 model and a more general model which includes the Brown–Singer σ-meson model. In the latter case the rate for $K^\pm \to \pi^\pm + \gamma + \gamma$ is found to be about 0.4% of the total decay rate. This suggests that this decay mode should be observable if a careful search is made. Events of this kind will alter the apparent $\pi^\pm$ spectrum in τ' decay so that the spectrum will not vanish at the end point. The rates for $K^\pm \to \pi^\pm + \gamma + e^+ + e^-$ and $K^\pm \to \pi^\pm + e^+ + e^-$ are expected to be considerably smaller. (auth)

9757 USE OF CURRENT ALGEBRA TO CALCULATE RADIATIVE CORRECTIONS TO THE β-DECAY CONSTANT IN THE THEORY WITH INTERMEDIATE BOSON. Ioffe, B. L. JETP Lett. (USSR) (Engl. Transl.), 4: 254-5(Nov. 1, 1966).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Redaktsiyu, 4: 376-8(Nov. 1, 1966).

Current algebra is used to show that the radiative corrections to the β-decay constants actually contain no form factors due to the strong interactions. This modified previous results. (J.F.P.)

9758 $\Delta S = 1$, $\Delta Q = 0$ DECAYS OF HADRONS IN THE QUARK MODEL. Ignatovich, V. K.; Struminskii, B. V. (Joint Inst. for Nuclear Research, Moscow). Phys. Lett., 24B: 69-71(Jan. 9, 1967).

The $\Delta S = 1$, $\Delta Q = 0$ decays of hadrons are considered in the framework of the quark model. The hyperon and meson decays are described by one phenomenological parameter. The decay rates for $\Sigma^+ \to p\gamma$, $K^+ \to \pi^+ + e^+ + e^-$, $K_2^0 \to 2\gamma$ are calculated. The results are in good agreement with experiment. (auth)

9759 NEUTRINO DISINTEGRATION OF THE DEUTERON. Kopysov, Yu. S.; Kuzmin, V. A. (Lebedev Inst. of Physics, Moscow). Yadern. Fiz., 4: 1031-6(Nov. 1966). (In Russian).

The cross section of the process $D + \nu \to p + p + e^-$ is calculated for the neutrino energies 4 MeV ≤ E_ν ≤ 20 MeV. Wave functions corresponding to a square nuclear potential well were taken for the deuteron and the two proton system. The uncertainty in the cross section is equal to ±8% and is mainly determined by the uncertainty of the pseudovector coupling constant. The cross section is well approximated by the function $\sigma = 1.96(10^{-44})$ (E/1 MeV − 1.443)$^{2.31}$ cm^2. The differential and integral electron spectra were obtained, as well as the integral cross sections for B^8 or He^3p neutrinos from the sun. (auth)

9760 DEUTERON AND WEAK INTERACTIONS. Smirnov, L. I. (Leningrad Pedagogical Inst.). Yadern. Fiz., 4: 1016-20 (Nov. 1966). (In Russian).

It is shown, that some interaction modes may be forbidden for various reaction channels in the weak nuclear process $l_1 + d \to N + N + l_2$. The connection between these selection rules and the structure of the nucleon wave functions is discussed. Relativistic generalizations of the "singlet" and "triplet" states are introduced. A formula is obtained for the differential cross section of the reaction $\nu_{\mu(e)} + d \to n + n + \mu^+ (e^+)$. (auth)

9761 K → 2π DECAYS IN THE MODEL WITH ICOSUPLET WEAK COUPLING HAMILTONIAN. Madzhumdar, Rabi; Anand, Dzhai Dev (Moscow State Univ.). JETP Lett. (USSR) (Engl. Transl.), 4: 328-9(Dec. 1, 1966).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Redaktsiyu, 4: 488-90(Dec. 1, 1966).

A special case of meson (K) decays neglecting the effects of CP violation is considered. The transformation property $H_w \sim (10) + 10^*$) is ascribed to the weak-interaction hamiltonian. It is shown that it is possible in this case to obtain a connection between the probabilities of these decays. This connection is a generalization of the corresponding rule for $\Delta T = \frac{1}{2}$. The corresponding spurions responsible for the K → 2π decay transform like states with Y = −1, from (10) and ½ and like states with Y = −1, and ³/₂ from (10*). (J.F.P.)

9762 PRODUCTION OF ELECTRONS AND POLARIZED BARYONS IN HIGH-ENERGY INTERACTIONS OF NEUTRINOS WITH POLARIZED NUCLEONS. Sarkar, S. (Indian Association for the Cultivation of Science, Jadavpur, India). Acta Phys. Acad. Sci. Hung., 21: 211-17(1966).

The cross section for the production of an electron or positron and a polarized baryon which may be a nucleon, or a hyperon, when a very high-energy neutrino or antineutrino interacts with a polarized nucleon target is calculated. The general result is discussed in the laboratory system of coordinates for some special cases which may facilitate the determination of the form factors associated with the various terms of the weak interaction. (auth)

9763 NONLINEAR DENSITY EFFECT IN THE TRANSMISSION OF K_2 MESONS THROUGH MATTER. Beall, E. F. (Univ. of Maryland, College Park). Contract AT(40-1)-2504. Phys. Rev., 152: 1486-9(Dec. 23, 1966). (ORO-2504-94).

It is noted that the attenuation of a monochromatic beam of K_2 mesons in an absorber is not simply describable in terms of a single "mean free path," even when the extent of the absorber is large in comparison with the K_1 mean decay length. The normal attenuation factor exp (−NσL) is to be corrected by a factor whose logarithm is nonlinear in the density N. The magnitude of this extra effect is discussed with the aid of a simple-minded model. The relation of the effect of the K_1–K_2 mass difference is briefly noted. (auth)

9764 DETERMINATION OF CABIBBO PARAMETERS FROM LEPTONIC BARYON DECAY. Carlson, Carl E. (Columbia Univ., New York). Phys. Rev., 152: 1433-6(Dec. 23, 1966). (NYO-1932-111).

The parameters D, F, and θ appearing in Cabibbo's theory for the weak baryon current were reevaluated, following Willis et al., using the latest available data on the leptonic decays of baryons. The momentum dependence of the form factors has been included. Seven data were used and three parameters fitted. The best least-squares fit to the data gives D = −0.766 ± 0.037, F = −0.415 ± 0.035, θ = 0.245 ± 0.010 [probability = 93% (χ^2 = 0.78)]. (auth)

9765 AXIAL-VECTOR, COUPLING-CONSTANT RENORMALIZATION AND WEAK INTERACTIONS. Iwao, S. (Univ., Bern). Nucl. Phys., 87: 571-7(1966).

Tomozawa's approach is extended to the charge-exchange scattering of the meson-nucleon interaction: $\pi^\pm$–π^0 mass differences are taken into account. The axial-vector, coupling-constant renormalization derived from $\pi^- + p \to \pi^0 + n$ for $K^{NN\pi}(0) = 1$ is found to be $|g_A| = 1.17 \pm 0.04$, which is compared to the absolute experimental value of $|(g_A)_{uncor}| = 1.175 \pm 0.02$. Both Adler-Weisberger and Tomozawa sum rules are applied to $\Xi^- \to \Xi^0$ beta decay and pion-Ξ scattering, respectively. Under reasonable assumptions the renormalized ΞΞπ coupling constant is calculated and gives a consistent solution. (auth)

Strong (General)

9766 REMARKS ON DIFFRACTION SCATTERING OF HADRONS AS SHADOW OF INELASTIC COLLISIONS. Zalewski, K.; Van Hove, L. (CERN, Geneva). Nuovo Cimento (10), 46A: 806-11(Dec. 21, 1966).

It is pointed out that certain assumptions for a class of models

previously found for the inelastic final states are not compatible with the simultaneous requirement that the overlap function is exponential and that the parameter in exponential overlap function does not decrease with decreasing energy. The difficulties are exposed, and possible modifications of the models which might be used in order to restore consistency are mentioned. (L.B.S.)

9767 POSSIBILITY OF EXISTENCE OF A QUARK STATE OF MATTER IN STARS. Manko, V. I.; Markov, M. A. (Lebedev Inst. of Physics, Moscow). Zh. Eksp. Teor. Fiz., 51: 1689-92 (Dec. 1966). (In Russian).

It is shown that in a superdense star a quark state of matter may be possible, and if the quarks are parafermions their concentration should be maximal. (auth)

9768 SEPARATION OF STRONG AND ELECTROMAGNETIC EFFECTS IN CHARGED-PARTICLE SCATTERING. Rix, J.; Thaler, R. M. (Case Inst. of Tech., Cleveland). Phys. Rev., 152: 1357-63(Dec. 23, 1966).

Data on the scattering of charged hadrons reflect both the strong and electromagnetic interactions. The problem of unraveling the "strong" part of the scattering amplitude from the electromagnetic part is examined. Specific prescriptions, involving only the use of observed scattering data, are derived for obtaining the connection between the idealized "strong" scattering amplitude and the observed full scattering amplitude. The importance of the "off-the-mass-shell" or model-dependent corrections, which cannot be obtained directly from observation, are also discussed briefly. These results are equally applicable in the domains of low-energy nuclear physics and high-energy physics. (auth)

9769 WEINSTEIN'S PREDECAY MIXING EFFECT. Jona-Lasinio, G.; Low, F. E. (Massachusetts Inst. of Tech., Cambridge). Contract AT(30-1)-2098. Phys. Rev., 152: 1411-7 (Dec. 23, 1966).

The predictions of a model are compared with the recent conjecture of Weinstein stating that in particular circumstances the mass and width of a resonance could be altered by the final-state interactions following the production process. This effect, which he calls predecay resonance mixing, should be observed in a reaction in which there is the possibility of producing either one of two resonances of comparable mass as, for example, ρ and ω. The model refers explicitly to the ρ-ω case but the conclusions drawn are entirely general and can be applied to any other similar case. The results can be formulated as follows. No finite-range final-state interaction can displace a resonance or change its width. However, the production amplitude acquires a modulating factor which can, in principle, considerably modify the production cross section. Additional peaks may appear simulating spurious resonances. These could be discriminated from true resonances by studying their energy dependence. (auth)

9770 COUPLED EQUATIONS FOR SCATTERING AMPLITUDES AND HADRONIC CURRENTS. Lu, E. Y. C.; Taha, M. O. (Cambridge Univ., Eng.). Phys. Rev., 152: 1507-11(Dec. 23, 1966).

The physical-region unitarity conditions are shown to lead to a set of integral equations explicitly coupling the scattering amplitudes and currents of the hadrons. The implications of this for the extent to which the currents are determined by the strong interactions, and their algebra induced by a strong-interaction symmetry, are discussed. The relation to the work of Dashen and Frautschi is discussed in an Appendix. (auth)

9771 N/D EFFECTIVE-RANGE THEORY WITH SU(3)-SYMMETRIC SHORT-RANGE FORCES. Balazs, Louis A. P. (Univ. of California, Los Angeles). Phys. Rev., 152: 1512-16(Dec. 23, 1966).

A simple N/D representation is written down in which nearby singularities (long-range contributions) are calculated explicitly from single-particle-exchange graphs in the conventional way. The remaining singularities (short-range forces) are not ignored, but are approximated in terms of two "effective-range" parameters. These are taken to be SU (3)-symmetric, an assumption which is closely related to the idea that internal symmetries should manifest themselves at high energies and momentum transfers. For instance, the parameters in the I = 1, J = $1\pi\pi$-$K\bar{K}$ problem can be related to the corresponding ones in the I = 0, J = 1 $K\bar{K}$ problem. Thus if the mass and width of the ρ meson are known from experiment, the corresponding quantities for the ϕ meson can be calculated. A simplified version of this calculation gives values in fairly good agreement with experiment. (auth)

9772 OVERLAPPING RESONANCES IN THREE-PARTICLE FINAL STATES. Chen, Fei Shian; Sommerfield, Charles M. (Yale Univ., New Haven). Phys. Rev., 152: 1401-7(Dec. 23, 1966).

The properties of a three-particle final state are investigated within the context of the Lee model in order to determine if the overlap of two two-particle resonances might simulate a genuine three-particle resonance. The process $\theta + V \rightarrow \theta + \theta + N$ is examined. Matters have been so arranged that there is an $N\theta$ resonance called V*. This can be brought about by introducing two elementary V fields. The $V\theta$ sector remains exactly solvable and the method of solution is presented together with analytic expressions for the $N\theta$ scattering amplitude and the $V\theta$ elastic and production amplitudes. An analysis of the overlapping V* resonances in the final $N\theta\theta$ state shows that there is no effect not explicable in terms of two-particle phase space and simple one-particle-exchange dynamics. However, through a faulty selection of production events and a corresponding misapplication of unstable-particle theory, an apparent $V^*\theta$ resonance can be generated. (auth)

9773 ISOSPIN CONSERVATION AND POLARIZATION EFFECTS. Bilenkii, S. M.; Lapidus, L. I.; Ryndin, R. M.; Shekhter, L. Sh. (Joint Inst. for Nuclear Research, Dubna, USSR). Yadern. Fiz., 4: 1063-6(Nov. 1966). (In Russian).

The reactions $a + a' \rightarrow b + b'$ are treated, where the particles a and a' (or b and b') belong to the same isotopic multiplet, and the total isotopic spin of the final (or initial) particles may take only one value. Relations were obtained between polarization characteristics of such reactions at the angles θ and $\pi - \theta$ (θ is the cms angle). These relations are based only on isotopic invariance and invariance under rotations and reflections. Their experimental verification would be a detailed test of the isotopic invariance of strong interactions. (auth)

9774 FACTORIZATION OF AMPLITUDES AND PAIR PRODUCTION OF RESONANCES AT HIGH ENERGIES. Kaidalov, A. B. (Inst. of Theoretical and Experimental Physics, Moscow). JETP Lett. (USSR) (Engl. Transl.), 4: 325-8(Dec. 1, 1966).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Redaktsiyu, 4: 484-8(Dec. 1, 1966).

A possible check on amplitude factorization in pair production of resonances with nonzero spins at high energy is discussed. A reaction in which the masses and spins of the participating particles are described by a polarization density matrix is considered. The spin states of the initial particles are uncorrelated, and the factorization condition leads to the absence of correlation between the spin states of the produced particles. (J.F.P.)

9775 SINGULAR STRING OF MAGNETIC MONOPOLES. Peres, Asher (Israel Inst. of Tech., Haifa). Phys. Rev. Lett., 18: 50-1(Jan. 9, 1967).

The significance of the string attached to the Dirac magnetic monopole is reviewed. A mechanism proposed by Schiff, to explain the absence of free quarks in nature, is shown to be invalid. (auth)

Strong (Baryon No. = 0)

9776 CURRENT ALGEBRAS AND THE DECAY $\omega \rightarrow \pi^+\pi^-\gamma$ Conway, P. D. (Cambridge Univ., Eng.). Phys. Lett., 24B: 59-60(Jan. 9, 1967).

An analysis of the decay mode $\omega = \pi^+\pi^-\gamma$ is given based on the Weinberg (Phys. Rev. Letters 17: 336 (1966)) extension of the current algebra technique. It is assumed that the mesons (π) are mainly in an S state and that there are no strong π-π S-wave interactions. (J.F.P.)

9777 CONTRIBUTION OF THE PERIPHERAL PART OF MANY-PARTICLE STATES TO THE UNITARITY CONDITION FOR $\pi\pi$-SCATTERING. Malkov, E. I. (Ioffe Inst. of Physics and Tech., Leningrad). Zh. Eksp. Teor. Fiz., 51: 1784-94(Dec. 1966). (In Russian).

The unitarity condition for the partial $\pi\pi$-scattering partial wave is deduced by taking into account that part of many-particle intermediate states which is produced and which goes over to the final state as a result of peripheral interaction. The contribution of this part of the many-particle intermediate states is expressed in terms of physical partial waves. The proposed expansion of the amplitude into a series which converges over the whole Z_s plane (Z_s is the cosine of the scattering angle in the s channel) and which possesses the property that its first N coefficients can be expressed only in terms of the first N partial waves is employed. The expansion is also used for obtaining an expression for the partial wave change $A_l(s)$ on the left cut which converges for all values of s. Application of this expression for the change $A_l(s)$ on the left cut permits one to remove the divergences which usually appear in the bootstrap problem for exchange in the crossing channel by a particle with a spin greater or equal to unity. (auth)

9778 SOFT-PION PRODUCTION AND ALGEBRA OF CURRENTS. Iwao, S. (Univ., Bern). Nucl. Phys., 87: 581-91 (1966).

The production of two soft pions in collision processes are investigated under the hypotheses of the algebra of currents and the

partially conserved axial-vector current. The condition of softness is made to meet with experimental situation. A general formula to estimate the two soft-pion production is derived. A scalar part as well as the normal isospin part of the reduction amplitude are included in this formula. The calculated cross section is large enough to be measured experimentally. The baryon-baryon collision and the production of double soft pions are studied in detail. Assuming the SU(3) symmetry for baryon systems, many sum rules and selection rules are obtained. The non-go selection rules are classified into three classes according to the forbiddenness of the scalar and isospin part of the reaction amplitude, viz. no scalar part and forbidden isospin part, allowed scalar part but forbidden by the isospin part, completely forbidden by both scalar and isospin part. (auth)

9779 TOTAL CROSS SECTIONS IN A QUARK MODEL. Chan, C. H. (Univ. of California, San Diego, La Jolla). Contract AT(11-1)-Gen-10. Phys. Rev., 152: 1244-6(Dec. 23, 1966). (UCSD-10P10-3).

Meson and baryon total scattering cross sections are obtained using a quark model. It is emphasized that from the assumption of additivity alone [independent of SU(2) or SU(3) symmetry assumptions], two sum rules exist. Experimentally, they can be tested easily. (auth)

9780 RENORMALIZED ω-ϕ MIXING ANGLE AND $J^P = 1^-$ MESON DECAYS. Rivers, R. J. (International Centre for Theoretical Physics, Trieste, Italy). Phys. Rev., 152: 1262-6(Dec. 23, 1966).

Simple field-theoretic arguments define a renormalized ω-ϕ mixing angle and compare predictions between the normalized and renormalized theories and experiment. The sensitivity of the predictions to the initial assumptions is briefly discussed. (auth)

9781 CONSEQUENCES OF THE QUARK MODEL FOR THE ANNIHILATION OF A PROTON-ANTIPROTON PAIR INTO A HYPERON-ANTIHYPERON PAIR. Rekalo, M. P. (Physico-Technical Inst., Academy of Sciences, Ukrainian SSR). JETP Lett. (USSR) (Engl. Transl.), 4: 334-6(Dec. 1, 1966).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Redaktsiyu, 4: 497-500(Dec. 1, 1966).

Consequences of the quark model for the annihilation of a nucleon-antinucleon pair into a pair of hyperons are discussed. It is assumed that the model considered is valid at high energies and relatively low momentum transfers when the final hyperon is emitted in the cms in the direction of the momentum of the initial nucleon and the antihyperon is emitted in the direction of the initial antiproton momentum. (J.F.P.)

9782 INTERMEDIATE VECTOR MESON MODEL FOR NUCLEON-ANTINUCLEON ANNIHILATIONS. Campbell, William Bruce. Boulder, Colo., Univ. of Colorado, 1966. 153p.

Nucleon-antinucleon annihilations are investigated using an intermediate vector meson model. It is assumed that the many pseudoscalar meson annihilations of nucleon-antinucleon pairs proceed via one or more vector mesons in the intermediate state. General calculations are made using Feynman techniques for annihilations into any number of pseudoscalar mesons. Following Sakurai, it is assumed that the mediating vector mesons are the ρ, ω, and ϕ meson resonances. The n-body unintegrated phase-space is given in terms of new variables which prove more useful for this model. Selection rules for the case where there is one intermediate vector meson are discussed. Specific calculations are made using the model and some numerical results are given for the processes $\bar{p}p \to \pi^+\pi^-$, $\bar{p}p \to \rho^+\rho^-$, $\bar{p}p \to 2\rho^0$, and $\bar{p}n \to \rho^-\rho^0$. The model predicts that the ratio of the cross section for the process $\bar{p}n \to \rho^-\rho^0$ to that for $\bar{p}p \to \rho^+\rho^-$ should be approximately fifty to one for an energy of 3.5 BeV in the barycentric frame. It is suggested that the model can best be tested by antiproton-neutron annihilations. (Dissertation Abstr.)

Strong (Baryon No. = 1)

Refer also to abstracts 9779 and 9831.

9783 (JINR-P1-3049) DIAGRAMMY DALITSA DLYA KASKADNYKH RASPADOV NA CHETYRE CHASTITSY. (Dalitz Plot for Four-Particle Cascade Decays). Kopylov, G. I. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of High Energy). 1966. 14p. (In Russian). Dep. mn.

A convenient pair of variables is found for the cascades decaying into four particles. In these variables all the states of four-particle system are equally probable when dynamic interactions inside the system are absent. The diagrams allow one to visualize the dynamic interactions in cascade decays. (auth)

9784 IMPLICATIONS OF THE PCAC HYPOTHESIS FOR THE K-ℓ INTERACTION. Ahmed, M. A. (Univ. of Durham, Eng.). Nuovo Cimento (10), 46A: 569-82(Dec. 21, 1966).

It is shown that a partially conserved strangeness-changing axial-vector current hypothesis leads to a condition on the K-ℓ scattering amplitude. The Λ-ℓ and Σ-ℓ mass differences are neglected. However, if the mass difference terms are retained a null condition is obtained instead $A^{K-\ell}(\nu = 0, \nu_B = 0, k^2 = 0) = 0$. (auth)

9785 AXIAL-VECTOR COUPLING CONSTANT RENORMALIZATION AND THE MESON-BARYON SCATTERING LENGTHS. Tomozawa, Y. (Institute for Advanced Study, Princeton, N. Y.). Nuovo Cimento (10), 46A: 707-17(Dec. 21, 1966).

Assuming that the current algebra of Gell-Mann and the PCAC (partially conserved axial-vector current) are valid approximations, and that a specific form of the LSZ reduction formula for pion-nucleon scattering amplitude has a small variation for the change of pion 4-momentum k_μ from (0, 0, 0, $i\mu_\pi$) to $k_\mu = 0$, two simple relations are derived between the axial-vector coupling constant renormalization g_A and the pion-nucleon scattering lengths. Both are satisfied quite well by the experimental values, and are shown to be intimately related with the Adler-Weisberger relation and the consistency condition of Adler. In a similar way, the scattering lengths of pion-baryon, pion-kaon, and kaon-nucleon systems are predicted. The assumption of the generalized form of PCAC in the SU_3 context leads to the prediction of the meson-baryon scattering lengths. They are identical to those which are calculated by the model of the vector-meson exchange with the universal F-type coupling. (auth)

9786 NOTE ON RESONANCE SCATTERING. Raszillier, I. (Inst. of Physics, Bucharest). Nuovo Cimento (10), 46A: 748-51(Dec. 21, 1966).

It is shown that the use of a certain form of higher-spin propagators in OPE theories eliminates contributions to wrong partial waves from direct diagrams. The contributions of a baryonic resonance of arbitrary spin are given explicitly in both the direct and crossed channel to the pion-nucleon scattering cross section. (L.B.S.)

9787 PREDICTIONS OF THE ALGEBRA OF CURRENTS AND OF A QUARK MODEL ABOUT THE MESON-BARYON COUPLING CONSTANTS. Eberle, E. (Univ., Genoa. Istituto Nazionale di Fisica Nucleare, Genoa). Nuovo Cimento (10), 46A: 803-5(Dec. 21, 1966).

It is pointed out that the almost complete coincidence of results previously obtained for sum rules connecting the baryon-ps-meson coupling constants by means of the algebra of currents and of a quark model stems essentially from the restrictive assumptions about the SU_3-violating contributions made in both approaches. It is shown that if the SU_3-breaking effects are assumed to depend exclusively on the pseudoscalar meson, the results obtained are already predicted by the usual broken SU_3 scheme alone. (L.B.S.)

9788 SUPERCONVERGENT CONSISTENCY CONDITIONS FOR THE π N P_{33} PARTIAL-WAVE AMPLITUDE. Goldberg, H. (Cornell Univ., Ithaca, N. Y.). Phys. Lett., 24B: 71-4(Jan. 9, 1967).

The sum rule obtained from a superconvergent πN partial wave dispersion relation is discussed. Reggeism is seen to be of little use in solving the ambiguities connected with high energy behavior. (auth)

9789 SUPERCONVERGENCE RELATION FOR PSEUDOSCALAR MESON-BARYON SCATTERING. Babu, P.; Gilman, F. J.; Suzuki, M. (California Inst. of Tech., Pasadena). Phys. Lett., 24B: 65-7(Jan. 9, 1967).

A possible strong interaction sum rule for pseudoscalar meson-baryon scattering, derived by assuming that the Regge trajectory α (t) for mesons with I = 2 (which could be assigned to the 27-dimensional representation of SU(3)) has α (0) < 0, is investigated. (J.F.P.)

9790 ON A GENERAL SOLUTION OF CHEW-LOW TYPE EQUATION. Meshcheryakov, V. A. (Joint Inst. for Nuclear Research, Dubna, USSR). Phys. Lett., 24B: 63-4(Jan. 9, 1967).

A method is proposed for solving equations of the Chew-Low type which describe the scattering of particles with spin l on the source with spin l_1. The method is based on the conformal mapping due to the function $w = (1/\pi)$ arc sin ω. As an example, a solution for $l, l_1 = 1$ is given. (auth)

9791 APPROXIMATE SATURATION OF SUPERCONVERGENCE RELATION. Altarelli, G.; Buccella, F.; Gatto, R. (Univ., Florence. Istituto Nazionale di Fisica Nucleare, Florence). Phys. Lett., 24B: 57-9(Jan. 9, 1967).

The saturation of a superconvergence relation for meson-baryon scattering is examined by inserting the presently available data on resonances. The agreement appears satisfactory. (auth)

9792 POSSIBLE EXISTENCE OF AN I = 0, D-WAVE $\pi\pi$ RESONANCE IN THE VICINITY OF THE ρ MESON. Desai, Bipin R.

(Univ. of California, Riverside). Contract AT(11-1)-34P107A. Phys. Rev., 152: 1428-32(Dec. 23, 1966).

A second peak in the vicinity of the ρ^0 peak has been seen in several recent experiments involving $\pi^- + p \rightarrow \pi^+ + \pi^- + n$ and $K^- + p \rightarrow \pi^+ + \pi^- + \Lambda$. It is suggested that this peak may be due to an I = 0, D-wave $\pi\pi$ resonance. On the basis of the experimental mass and angular distribution of the 2π system, the resonance is predicted to be at an energy of about 780 MeV with a width of 5 MeV. A strong S wave at lower energies is also needed. Our D resonance is the most logical candidate for the 2^+ SU(3) singlet which is, as pointed out recently by Desai and Freund, needed to explain the high-energy behavior of the meson-baryon and baryon-baryon total cross sections. It is suggested that, it is this particle, not f, which should lie on the Pomeranchuk trajectory. It is argued that the strong attraction which the Pomeranchuk particle is known to receive and a strong centrifugal barrier typical of an l = 2 state may well conspire to produce a narrow resonance at a low mass of the kind proposed here. A narrow-resolution $\pi^- + p \rightarrow \pi^0 + \pi^0 + n$ and $K^- + p \rightarrow \pi^0 + \pi^0 + \Lambda$ are perhaps the best experiments to isolate the D wave and to determine whether it is this resonance or some other mechanism, such as $\omega \rightarrow 2\pi$, which is responsible for the second peak. (auth)

9793 VERTEX SYMMETRY AND THE RECIPROCAL BOOTSTRAP. Whippman, M. L. (Univ. of Pennsylvania, Philadelphia). Contract AT(30-1)-2171. Phys. Rev., 152: 1269-73(Dec. 23, 1966). (NYO-2171-205).

A vertex-symmetric, time-reversal invariant bootstrap is formulated in a multichannel version of the static model. The results are applied to the coupled πN and πN^* channels, and to the infinite baryon tower of states with I = J. The coupled-channel problem is shown to be equivalent to the uncoupled problem, and the implications for approximate calculations are discussed briefly. (auth)

9794 CAPTURE OF A $\overline{K}$ MESON FROM THE 2P ORBIT IN ^{4}He FOLLOWED BY π^- AND Λ^0 PRODUCTION. Sawicki, J. (Institut de Physique Nucleaire, Orsay, France). Phys. Rev., 152: 1246-9(Dec. 23, 1966).

The reaction $\overline{K} + {}^4He \rightarrow \pi^- + \Lambda^0 + {}^3He$ is studied under the assumption of capture from the 2P Bohr orbit. The outgoing pion and the recoiling ^{3}He momentum distributions are calculated with the inclusion of Y_1^*-resonance and Σ-Λ conversion amplitudes. The Σ-Λ conversion process is of particular importance. The main conclusion is that the pion spectrum tends to favor the assumption that the stopping $\overline{K}$ are captured from a P-state atomic orbit. The conclusion is consistent with the results of the $\overline{K}$-capture x-ray experiment of Burleson et al. (auth)

9795 IS THE NUCLEON A πN BOUND STATE? Nath, Pran (Univ. of Pittsburgh); Vasavada, Kashyap V. Phys. Rev., 152: 1254-8(Dec. 23, 1966).

The P_{11} partial wave of the πN system is characterized by a large absorption and a resonance (possibly inelastic) at 575-MeV laboratory pion energy (Roper resonance). In view of these features of the P_{11} channel, the πN system may be rendered sufficiently weak not to bind the nucleon. Using the experimental mass of the nucleon and the recently obtained extensive energy-dependent, complex phase-shift results of πN scattering data, the existence of a nucleon bound state in the πN channel in the absence of forces arising from the inelastic states is examined through a nonperturbative S-matrix approach. The formalism is independent of any model for the contribution of the left-hand cut. Two different possibilities concerning the nature of the Roper resonance are discussed: (a) it is an elastic resonance primarily due to the forces in the πN channel; (b) it is an inelastic resonance mainly due to the forces from the inelastic states. In either case it is found unlikely that the πN system by itself can sustain the nucleon bound state. (auth)

9796 RADIUS OF THE NUCLEON IN A BOUND-STATE MODEL. Vasavada, Kashyap V. (Goddard Space Flight Center, Greenbelt, Md.); Kim, Y. S. Phys. Rev., 152: 1259-62(Dec. 23, 1966).

The nucleon radius is estimated from the pion-nucleon phase shifts, assuming that the nucleon is a bound state of the pion and the nucleon. The calculation is based on the one-pole approximation of the Gelfand-Levitan formalism on the inverse scattering problem. The numerical result of 0.15-0.50 F is obtained for the radius. In this connection, the properties of the phase shift and also of the D function for the appropriate channel are discussed. (auth)

9797 MESON-BARYON AND BARYON-BARYON REACTIONS IN A QUARK MODEL. Lipkin, H. J.; Scheck, F.; Stern, H. (Weizmann Inst. of Science, Rehovoth, Israel). Phys. Rev., 152: 1375-82(Dec. 23, 1966).

An "independent-quark model" for mesons and baryons which recently was applied very successfully to elastic scattering at high energies, is extended to inelastic meson-baryon and baryon-baryon reactions. A number of relations between cross sections are derived, most of which are independent of SU(3). The agreement with the available data is fair except for one case, but more data at higher energies are needed for a detailed test of the model. (auth)

9798 HIGH-SPIN BARYONS. I. THE PION-BARYON-BARYON VERTEX. Carruthers, P. (Cornell Univ., Ithaca, N. Y.). Phys. Rev., 152: 1345-51(Dec. 23, 1966).

A simple analysis is given for the coupling of a pion to baryons of arbitrary spins and parities. The structure of the vertex depends on a new quantum number called γ parity. Recursion formulas are given relating high-spin vertices to lower spin vertices. The recursion formulas are solved to give explicit formulas for the πBB' vertex when one baryon is at rest. New polynomials in the energy variable are introduced for this purpose. A symmetry relation is derived which connects vertex functions of opposite γ parity and opposite energy of the moving baryon. The isospin structure of the vertex is analyzed in order to obtain a standardized form useful in comparing effective coupling constants. "Transition isospin matrices" are introduced and their properties derived. General, explicit formulas for decay widths are given for arbitrary-spin transitions of the baryons. No trace calculations are required. (auth)

9799 VANISHING OF PROPER VERTEX FUNCTIONS AS A CONDITION FOR REGGEIZATION OF ELEMENTARY PARTICLES. Saito, Takesi (Univ. of California, Berkeley). Contract W-7405-eng-48. Phys. Rev., 152: 1339-44(Dec. 23, 1966). (UCRL-16812).

The connection between Regge poles and elementary-particle poles was explored previously. Use was made of the approximation of elastic unitarity and of the assumption of no Castillejo-Dalitz-Dyson (CDD) ambiguity. The CDD ambiguity is included, and it is shown without recourse to any approximation that the vanishing of $\Gamma(s)$ (the renormalized pion-nucleon proper vertex function with one nucleon off the mass shell) is a necessary and sufficient condition for the elementary nucleon to lie on the Regge trajectory. From the condition $\Gamma(s) \equiv 0$ it also follows that $Z_1 = Z_2 = Z_2\delta M = 0$, where Z_1 is the vertex-renormalization constant Z_2 is the nucleon wave-function renormalization constant, and δM is the nucleon self-mass. But the vanishing of $\Gamma(s)$ does not always follow from $Z_1 = Z_2 = Z_2\delta M = 0$. Therefore, the so far widely recognized compositeness condition, $Z_1 = Z_2 = 0$, or $Z_2 = 0$ with finite self-mass, is not sufficient to Reggeize the elementary nucleon. Finally, Kaus and Zachariasen's criterion for Reggeization is discussed. Their criterion is not necessary to Reggeize the elementary nucleon; it should be modified to $\Gamma(s)\ K(s) \equiv 0$ and $g_{B\beta} = 0$, where $g_{B\beta}$ is the residue of the extra pole in the pion-nucleon scattering amplitude and K(s) is the pion-nucleon form factor with one nucleon off the mass shell. (auth)

9800 NEW DETERMINATION OF THE P' REGGE TRAJECTORY INTERCEPT. Scanio, Joseph J. G. (Univ. of California, Berkeley). Contract W-7405-eng-48. Phys. Rev., 152: 1337-8(Dec. 23, 1966). (UCRL-16766).

A precise value of the P' Regge-trajectory intercept at t = 0 is calculated using a modified form of the Igi sum rule and new data on pion-nucleon total cross sections. (auth)

9801 PION-NUCLEON SCATTERING IN THE P_{11} STATE. Schwarz, John H. (Univ. of California, Berkeley). Contract W-7405-eng-48. Phys. Rev., 152: 1325-36(Dec. 23, 1966). (UCRL-16933).

The P_{11} pion-nucleon scattering amplitude is studied in order to determine the dynamical status of the nucleon. A simple one-channel static model is constructed in which a good fit to the low-energy data is obtained with a Castillejo-Dalitz-Dyson (CDD) pole. If there is, in fact, such a pole, with the strength indicated by our model, then one must conclude that other channels play a significant, although not overwhelming, part in forming the nucleon. It is also possible to reconcile all the available information with a model containing no CDD poles in which the nucleon is formed to a good approximation in the pion-nucleon channel alone. A few ways by which one may hope to choose between the two models are discussed. It is shown how the success of certain "reciprocal bootstrap" calculations can be understood, whether or not a CDD pole is required. The large inelasticity and phase shift in the P_{11} pion-nucleon channel at energies of 400 to 600 MeV are probably due to coupling with the $\pi\pi$N channel, with all three particles in relative s waves. This latter channel seems to be significant for the properties of the 1400-MeV (Roper) resonance, but probably plays a small role in the formation of the nucleon. (auth)

9802 CHEW-LOW MODEL FOR REGGE-POLE COUPLINGS. Dashen, Roger; Frautschi, Steven (California Inst. of Tech., Pasadena). Contract AT(11-1)-68. Phys. Rev., 152: 1450-3 (Dec. 23, 1966). (CALT-68-86).

The couplings of a meson trajectory $\alpha(t)$ to the baryon octet B and the decimet Δ are studied in the Chew-Low model. The model

predicts ratios, though not absolute magnitudes, for SU(3)-symmetric couplings of the 0^- octet II, 1^- octet V, and 2^+ octet T trajectories at the small t of either sign for which static kinematics is applicable. For non-spin-flip, the V and T trajectories are predicted to couple to $\overline{B}B$ like $F + \frac{1}{4} D$, independent of t. For magnetic dipole terms, the II, V, and T trajectories are all predicted to couple to $\overline{B}B$ like $D + \frac{2}{3} F$, and to $\overline{\Delta}B$ with the same relative strength as the 0^- octet, independent of t. The electric quadrupole couplings of the II, V, and T trajectories are predicted to be small, independent of t. These results generally agree with existing data, improve Sawyer's explanation of the Johnson-Treiman relations, provide a partial justification of the recent suggestion that V and T couplings are similar, predict that T exchange produces large spin flips, and predict certain ratios such as $d\sigma/dt(\pi^-p \to \pi^0n)/(d\sigma/dt)\ (\pi^+p \to \pi^0N^{*++})$. (auth)

9803 PHOTOPRODUCTION OF VECTOR MESONS. II. Srinivasan, S. K.; Achuthan, P. (Indian Inst. of Tech., Madras). Nucl. Phys., 87: 605-17(1966).

Cross sections for the production of ω and ρ mesons in photon-nucleon collisions were extended to include additional angles and higher energies. While in the case of ω, the OPE model is predominant, it is found that for the ρ production, the nucleon intermediate state is strikingly significant. (auth)

9804 COMPLETE EXPERIMENT FOR THE ISOBAR PRODUCTION IN MESON–NUCLEON SCATTERING. Dubovikov, M. S. (Moscow Inst. of Physics and Tech.). Yadern. Fiz., 4: 1058-62(Nov. 1966). (In Russian).

The reaction amplitudes of $\pi_1 + p \to \pi_2 + N^*$ are expressed in terms of polarization effects in this process. The number of real parameters, determining this process is found, which cannot be checked in simpler experiments than the complete one. (auth)

9805 SIMPLEST INELASTIC PROCESSES AT HIGH ENERGIES. Ter-Martirosyan, K. A. (Inst. of Theoretical and Experimental Physics, Moscow). Yadern. Fiz., 4: 1067-71(Nov. 1966). (In Russian).

Experimental data on the reactions $\pi^-p \to \pi^0n$ and $\pi^-p \to \eta^0n$ are analyzed. It is shown that they testify to the Regge type energy dependence of the cross sections, to make it possible to determine the parameters of the theory and to extrapolate the cross section values to the region of several hundred GeV. An experiment is suggested to investigate the Regge type, i.e., polynomial dependence of the cross section for the production of several particles in a narrow forward cone on the mass of two-particle system. (auth)

9806 QUARK MODEL OF BACKWARD SCATTERING. Lyubimov, A. L. (Joint Inst. for Nuclear Research, Dubna, USSR). JETP Lett. (USSR) (Engl. Transl.), 4: 331-4(Dec. 1, 1966).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Redaktsiyu, 4: 493-7(Dec. 1, 1966).

Some consequences ensuing to the process of backward scattering from the quark model are indicated, and these consequences are compared with experimental data. Some details of the model are also proposed for the purpose of obtaining quantitative relations between the cross sections of different processes. (J.F.P.)

9807 PHENOMENOLOGICAL ANALYSIS OF PION PRODUCTION. Wilson, William Anthony. San Diego, Calif., Univ. of California, 1966. 76p.

Thesis

Relativistic orbital three-body states are developed and studied. These states transform under Lorentz transformation according to Wigner's prescription. The states are used to obtain a partial wave expansion of pion production with special emphasis on the cutoff. An attempt is made to fit the differential cross section for the reaction $\pi + N \to \pi + \pi + N$ using the partial wave amplitudes. (Dissertation Abstr.)

Strong (Baryon No. ≥ 2)

Refer also to abstract 9797.

9808 DETERMINATION OF n–d SCATTERING LENGTHS. Pett, T. G. (London Univ.). Phys. Lett., 24B: 25-7(Jan. 9, 1967).

Efimov's calculations are modified by appropriately normalizing the trial wave functions so that, with the use of Kohn's variational method and with certain conditions in the doublet case, upper bounds are given on the quartet and doublet n-d scattering lengths. The calculations are carried out firstly, assuming no distortion of the deuteron and secondly, with distortion terms included in the trial wave function. The quartet results show excellent agreement with set of the experimental values, and the doublet results indicate that distortion is important factor, and that the Gaussian potential used is inappropriate for describing doublet n-d scattering. (auth)

9809 SHRINKING OF THE p-p SCATTERING DIFFRACTION PEAK FOR LARGE MOMENTUM TRANSFERS. Bailey, D. T. (North American Aviation, Tulsa, Okla.); Ingraham, R. L. Phys. Rev., 152: 1290-5(Dec. 23, 1966).

The p-p elastic-scattering cross section can be explicitly calculated in quantum field theory endowed with a fundamental length in the limit of very high energy and large momentum transfer, assuming that a simple (vector-meson) interaction is dominant. Plots of $X \equiv \log_{10}[(d\sigma/d\Omega)_{c.m.}/(\sigma p/4\pi)^2]$ are given for various lab momenta $P \geq 10$ GeV/c and momentum transfers $-t \geq 10$ $(GeV/c)^2$. In this range X involves only a single, additive parameter. A strong energy dependence, which gives the observed great shrinking, enters through the "kinematical form factors" attached to the external lines and is thus an immediate consequence of a fundamental length. The fit to the experimental points is excellent for a coupling constant of strong-interaction size if $\lambda \approx 0.5 \times 10^{-14}$ cm. (auth)

9810 SUBSIDIARY REGGE TRAJECTORIES WITH SINGULAR RESIDUES. NUCLEON–NUCLEON SCATTERING. Durand III, Loyal (Univ. of Wisconsin, Madison). Phys. Rev. Lett., 18: 58-62(Jan. 9, 1967).

It is pointed out that the existence of secondary Regge trajectories with intercepts $\alpha(0)$ which differ by integers from that of the leading trajectory at $t = 0$, and residues which are singular at that point, is a very general phenomenon which should occur both in the scattering of particles with spin, and in the scattering of particles of unequal mass. Rules are given for determining if such trajectories exist, and for determining their properties. The case of nucleon-nucleon scattering is discussed as an example. (auth)

9811 UNITARITY CORRECTIONS AND A FOUR-POLE FIT TO PERIPHERAL p-p SCATTERING BELOW 350 MeV. Arndt, R. A.; Bryan, R. A.; MacGregor, M. H. (Univ. of California, Livermore). Contract W-7405-eng-48. Phys. Rev., 152: 1490-1504(Dec. 23, 1966). (UCRL–14807-T).

Proton-proton partial-wave amplitudes for $l \geq 1$ and for lab kinetic energies below 350 MeV are fitted with a collection of single-particle exchanges taken in Born (fixed-pole) approximation. Since the Born terms are real, and consequently nonunitary, a correction term is added which makes the full amplitude unitary, and which at the same time satisfies the appropriate dispersion relation and threshold condition. The nature of this correction term and of its association with a strip approximation to the Mandelstam representation are discussed. The particle parameters were fitted to a reduced matrix representation of the p-p data, as described by Arndt and MacGregor in another publication. The S-wave dependence was removed in a manner also discussed by these authors. The gross structure of the partial-wave amplitudes is found to be approximately given by a sum of four meson-exchange poles, those corresponding to a π meson ($J^P = 0^-$, I = 1, $g_\pi^2 = 14$, $M_\pi = 135$ MeV), a σ meson ($J^P = 0^+$, I = 0, $g_\sigma^2 = 2.9$, $M_\sigma = 450$ MeV) an ω meson ($J^P = 1^-$, I = 0, $g_\omega^2 = 4$, $(f/g)_\omega = 0$, $M_\omega = 783$ MeV), and a ρ meson ($J^P = 1^-$, I = 1, $g_\rho^2 = 1.2$, $(f/g)_\rho = 4$, $M_\rho = 763$ MeV). The searched parameters were g_π^2, g_σ^2, g_ω^2, g_ρ^2, and M_σ; the remaining parameters were fixed at their "physical" values. It is further found that the relatively small unitarizing corrections play an essential role in determining the goodness of fit, but they do not appreciably alter the pole parameters determined from the search. Studies were also undertaken to determine the manner in which this (obviously low-energy) model becomes quantitatively worse as low-angular-momentum and high-energy contributions are added to the calculation. (auth)

9812 THE PRODUCTION OF Λ^0 AND π^- IN THE ABSORPTION OF K^- BY DEUTERIUM. Letessier, J. (Univ., Bordeaux); Vinh Mau, R. Nucl. Phys., 87: 625-38(1966). (In French).

The energy spectra of the protons and the π^- mesons produced in the process $K^- + d \to \Lambda^0 + p + \pi^-$ are calculated in the framework of the impulse approximation. The effects of the baryonic resonances Y_1^*, N_1^*, and Y_0^*, Y_0^{**} are taken into account respectively in the Λ^0 direct production and the Σ–Λ conversion processes. The influence of the final state interaction between the produced hyperon and proton is also studied. (auth)

9813 APPROXIMATION METHOD FOR DOUBLE-SCATTERING INTEGRALS. Sobel, M. I. (Brooklyn Coll.). Phys. Rev., 152: 1385-9(Dec. 23, 1966).

A method is suggested for approximately evaluating matrix elements for double-scattering processes. The method of performing integrals is illustrated in the cases of inelastic p-d scattering and p-p bremsstrahlung. The correction to p-p bremsstrahlung is found to be not greater than 7%. (auth)

9814 DECAY OF DOUBLE HYPERNUCLEI WITH THE EMISSION OF Σ-HYPERONS. Filimonov, V. A. (Inst. of Nuclear Physics, Electronics, and Automatics, Tomsk Polytechnic Inst., USSR). Yadern. Fiz., 4: 1010-15(Nov. 1966). (In Russian).

It is shown that specific decays of double hypernuclei with the

emission of Σ-hyperons can exist. Such a decay can arise as the result of the process $\Lambda + \Lambda \rightarrow \Sigma + N$. Some possible mechanisms of the mentioned process are considered: the direct four-fermion interaction and π meson exchange. The Σ-emission decay probability is estimated for ${}_{\Lambda\Lambda}He^{6}$, ${}_{\Lambda\Lambda}Be^{10}$ and heavy hypernuclei. According to these estimations, the Σ-hyperon emission decay probabilities for hypernuclei will be of the same order of magnitude as the meson emission decay probabilities. (auth)

Particle Invariance Principles and Symmetries

General

9815 (JINR-E2-3044) DYNAMICAL GROUP OF THE SCALAR SU(3) SYMMETRIC STRONG COUPLING THEORY. Bednar, M.; Tolar, J. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1966. 21p. Dep. mn.

Using a simple minimalization requirement for the $SU(3) \cdot T_8$ invariant part of the Hamiltonian of the scalar SU(3) symmetric strong coupling theory the physical unitary irreducible representation of the dynamical group $SU(3) \cdot T_8$ was found and its composition in terms of SU(3)-representations was determined. This approach permits a simple explanation of the presence of the SU(3) singlet in the case of pure D-coupling. (auth)

9816 FUNDAMENTAL CONCEPTS OF THE GROUP THEORY APPLIED IN THE ELEMENTARY PARTICLE PHYSICS. Kotanski, Andrzej (Univ., Jagiellonskiego, Poland). Postepy Fiz., 17: 485-96(1966). (In Polish).

Fundamental concepts of group theory are shortly discussed and compared with the corresponding concepts of quantum mechanics (e.g., irreducibility with elementarity). Consequences of a symmetry for free and interacting particles are described. Finally, the notions such as the Casimir operators, the Clebsch-Gordan coefficients, and the Clebsch-Gordan series are discussed for the following groups: translations on a straight line, three-dimensional rotations, SU_3, and the Poincaré group. (auth)

9817 A PARAMETRIC REPRESENTATION OF THE LIE ALGEBRA OF THE SU(2,2) GROUP CONSIDERED AS AN ISOMETRY GROUP ON A FIVE-DIMENSIONAL RIEMANN VARIETY. Gueret, Philippe; Vigier, Jean-Pierre (Institut Henri Poincare, Paris). Compt. Rend., Ser. B, 263: 1085-8(Nov. 14, 1966). (In French).

From a representation of the Lie algebra of locally isomorphous SU(2,2) and SO(4,2) groups considered as groups of isometric movement on the five-dimensional hyperbolic sphere Σ_5, the fifteen Cartan generators of these groups and the elements of different subgroups, interesting from the viewpoint of elementary particles, are constructed. A correspondence is established with the generators of the conform group in the Minkowski space and the conditions of passage to the de Sitter group and space are defined. (auth)

9818 SUPERCONVERGENT AMPLITUDES AND REPRESENTATIONS OF SL(2,R). Giovannini, A.; Predazzi, E. (Univ., Turin. Istituto Nazionale di Fisica Nucleare, Turin). Phys. Lett., 24B: 68-9(Jan. 9, 1967).

It is shown that the assumption that superconvergent amplitudes satisfy a dispersion relation is enough to prove that they form the basis of one of the principal series of SL (2,R). (auth)

9819 MASS SPLITTING IN SPIN-UNITARY SPIN HIGHER SYMMETRY SCHEMES. Thompson, K. W. (Univ. of Durham, Eng.). Nucl. Phys., 87: 592-6(1966).

A method of allowing mass splitting in $\tilde{U}(12)$ or $\tilde{U}(8)$ multiplets is suggested. Instead of breaking these groups by requiring the invariance of generalized Bargmann-Wigner equations, the symmetry is broken by first decomposing the representations with respect to the $U(3) \times \tilde{Sp}(4)$ or $U(2) \times \tilde{Sp}(4)$ subgroups and then requiring the invariance of these subgroups under Bargmann-Wigner equations. The particular representations of importance in comparison with experiment are discussed in detail, and it is shown how explicit masses rather than "averages" occur in $\tilde{U}(12)$ or $\tilde{U}(8)$ predictions. (auth)

9820 ELECTRIC DIPOLE OPERATORS IN THE CONFIGURATION MIXING SCHEME. Gatto, R. (Univ., Florence); Maiani, L.; Preparata, G. Phys. Rev. Lett., 18: 97-100(Jan. 16, 1967).

The phenomenological assumption is made that the electric dipole operators at infinite momentum have components both in the (8,1) and (1,8) representation of the collinear group and in the (3,3*) and (3*,3) representation. Under this assumption, the algebra of dipoles, in the usual configuration mixing scheme, provides very accurate relations for the baryon magnetic moments and charge radii. The over-all scheme seems thus capable of consistent predictions for all low-energy baryon parameters. (auth)

9821 NONDYNAMICAL FORMALISM AND TESTS OF TIME-REVERSAL INVARIANCE. Csonka, Paul L.; Moravcsik, Michael J. (Univ. of California, Livermore). Contract W-7405-eng-48. Phys. Rev., 152: 1310-24(Dec. 23, 1966). (UCRL-14843-T).

Those consequences of time-reversal invariance (or, briefly, T invariance) that are independent of dynamics are considered. A general prescription is developed to find all those tests of T invariance which are valid for arbitrary values of the form factors. Our considerations are independent of whether or not any of the other usual conservation laws (such as parity conservation) hold. The spins of the particles may be arbitrary. The results and methods of earlier papers dealing with the nondynamical properties of particle reactions are used. For elastic processes it is shown that T invariance eliminates some of the product sets and curtails others, but that no entire subclasses are eliminated. The restrictions on observables imposed by T invariance are of two types: There are so-called "mirror relations" between pairs of observable components, and there are relations which are not of the mirror type and involve a number of observable components. It is shown that the number of relations of the latter type is always nonzero whenever T invariance is not implied by other assumed conservation laws. Therefore, the mirror relations do not form a complete set of tests of T invariance. They do not even form a sufficient set of such tests, as they can be satisfied by a symmetric as well as an antisymmetric M matrix. A proof is given that in any non-mirror-type relation no particle is unpolarized in all the observable components which appear in the relation. It is also shown that the only reaction in which all mirror relations follow from parity conservation alone is the reaction involving two spin-$\frac{1}{2}$ and two spin-0 particles. A number of examples of elastic reactions are worked out in detail. For inelastic reactions the results are less interesting, since the restrictions imposed by T invariance can all be written as mirror-type relations between observable components of the direct and time-reversed reactions. (auth)

9822 ALGEBRAIC METHODS IN THE THEORY OF SPECIAL UNITARY GROUPS. I. CALCULATION OF GENERATOR MATRIX ELEMENTS. Nyiri, J.; Sebestyen, A. Acta Phys. Acad. Sci. Hung., 21: 243-53(1966).

The efficiency of simple algebraic methods is demonstrated in the theory of the special unitary groups. The calculation of the generator matrix elements is considered. The procedure is considered in detail in the framework of SU(3). (auth)

9823 SPONTANEOUSLY BROKEN SYMMETRIES AND CURRENT CONSERVATION. Maris, Th. A. J.; Jacob, Gerhard (Univ. Federal do Rio Grande do Sul, Porto Alegre, Brazil). Phys. Rev. Lett., 17: 1300-2(Dec. 26, 1966).

It is often argued that spontaneously broken symmetry (SBS) theories cannot explain the approximate symmetries of hadron and high-energy lepton physics because the expected conserved currents (and their Goldstone bosons or long-range interactions) are not observed. It is shown that this argument is probably incorrect because it appears that a SBS current is in general not conserved. (B.G.D.)

9824 HIGHER MESON RESONANCES IN THE SU(6) SYMMETRY. Montvay, I.; Nagy, T. (Roland Eoetvoes Univ., Budapest). Acta Phys. Acad. Sci. Hung., 21: 345-65(1966).

The mass values of positive-parity meson resonances are compared in 189 and 405 with predictions of simple SU(6) mass formulas. It turns out that the 2^+ mesons alone can be assigned to both 189 and 405. Nevertheless 405 seems to be more promising, for it allows inclusion of all well-established positive-parity mesons. (auth)

9825 MASS FORMULAS IN THE INHOMOGENEOUS SU(6,6) GROUP. Nikolov, A. V.; Todorov, I. T. (Joint Inst. for Nuclear Research, Dubna, USSR). Yadern. Fiz., 4: 1052-7(Nov. 1966). (In Russian).

A symmetry breaking for the inhomogeneous SU(6,6) group is introduced in the following way: it is required that the commutators of the 143-momentum P with isospin and hypercharge give zero when acting on physical states. Using this and the invariance of $Tr\ P^2$, quadratic mass formulas are obtained both for mesons and baryons. For the mesons the obtained relations are satisfied within an accuracy greater than 1%. The agreement of the mass formulas for baryons with experiment is not so good. (auth)

9826 DETERMINATION OF A SYMMETRY BREAKING INTERACTION POTENTIAL. Bierter, W. (Univ., Heidelberg). Z. Phys., 198: 373-85(1967).

Recently a formalism using group theoretical methods was de-

veloped which allowed a description of the degree of violation of a given symmetry property. This information is used for the construction of the corresponding responsible symmetry breaking interaction potential. For this purpose a coupled system of Gel'fand-Levitan equations is deduced for arbitrary compact groups. (auth)

Applications (Electromagnetic and Weak)

9827 SU(6), RP INVARIANCE, AND NONMESONIC DECAY OF HYPERNUCLEI. Itoh, Chiaki (Tokyo Univ. of Education). Progr. Theoret. Phys. (Kyoto), 36: 761-72(Oct. 1966).

Introducing the 56 and 56* baryon multiplets of SU(6), nonleptonic weak interactions can be made RP invariant. Then the relations among nonleptonic hyperon decay amplitudes are analogous to those in SU(3), and consistent with experiment. These interactions are applied to the weak vertices for the pseudoscalar meson and vector meson exchange terms of the weak interaction $\Lambda + N \rightarrow N + N$, which is important in the nonmesonic decay of hypernuclei. The dominance of the transition $^3S_1 \rightarrow {}^3P_1$ can be explained in the model. It is pointed out that strong vertices cannot be RP invariant, even if 56 and 56* baryons are introduced. This may mean that the 10* baryon, which is introduced to make nonleptonic interactions RP invariant, has no strong interaction with the 35 meson, but has nonleptonic weak interactions. (Also 10* may have electromagnetic interactions.) Possible decay modes of 10* are given. (auth)

9828 BARYON MASS SPECTRA IN A DYNAMICAL S-WAVE SU(6) MODEL. Koerner, Juergen G. (Northwestern Univ., Evanston, Ill.). Phys. Rev., 152: 1389-1400(Dec. 23, 1966).

Some results on the mass spectra of $56^{(+)}$ and the proposed $70^{(-)}$ and $20^{(+)}$ SU(6) baryon multiplets are presented as calculated from a simple S-wave SU(6)-invariant dynamical model involving first-order mass deviations. We take the meson masses from experiment and obtain reasonable agreement with the experimentally known baryon masses. The masses of the missing members of the multiplets are estimated. The mass spectrum of the 70 is discussed in detail. A two-parameter calculation using the experimental 56 and 35 mass spectra yields a mass spectrum in qualitative agreement with a recent nondynamical calculation of Gyuk and Tuan, in which 6 parameters have been used. The three mixing angles occurring in the 70 are estimated from the model and found to be small. On this basis some new approximate mass rules are given. Explicit representations are presented for the reduced matrix elements of the strong interaction mass operator for the SU(6) 35, 56, 70, and 20 representations. (auth)

9829 ISOTOPIC SPIN IN THE THEORY OF CP-ODD WEAK INTERACTION. Shabalin, E. P. (Inst. of Theoretical and Experimental Physics, Moscow). Yadern. Fiz., 4: 1037-44(Nov. 1966). (In Russian).

The properties of the CP-odd weak interaction in the isotopic space are considered. The Lagrangian of such an interaction has the properties of a vector in isospace and does not contain neutral current interactions, or interactions quadratic in the individual weak currents. Pseudo isomultiplets are introduced, so as to reduce the strangeness-changing interaction to the case with $\Delta S = 0$. The isotopic formalism then makes it possible to connect amplitudes of $\Delta S = 1$ processes with those of strangeness-conserving processes. Decays of K-mesons and leptonic hyperon decays are considered as an illustration of the method. Effects due to interactions with CP = −1 are considered, in particular the CP-parity violation in hadronic interactions. (auth)

Applications (Strong)

Refer also to abstract 9771.

9830 RATIO BETWEEN COUPLING CONSTANTS OF SUMMIT 70* 56 35. Volkov, D. V.; Kuraev, E. A.; Tkach, V. I. Ukr. Fiz. Zh., 11: 1296-1301(1966). (In Ukrainian).

A great deal of experimental data were recently accumulated on the properties of baryon resonances — candidates for filling representation SU (6) of dimensionality 70. Hence, the question of unitary symmetry of summit 70* 56 35, which corresponds to the simplest channels of formation and decay of these resonances, is of great interest. The group SU (3) × SU (3) × U is a symmetry group of the investigated summit in the rest system of a decaying particle; U is a group of rotations relative to the spatial part of pulses of the flying apart particles. P is constructed, the even amplitude of the summit of nine independent SU (3) × SU (3) invariants, which can be expanded into 5 classes: A [(1/2), (1/2) 1]; A [(1/2), (3/2) 1]; A [(3/2), (1/2) 1]; A [(1/2), (1/2) 0]; A [(3/2), (3/2) 0]. Ratios are obtained between the coupling constants of three-part summits with given projections of the spins of these particles on the $\vec{q}$ axis. Their checkup is possible in experiments with polarized resonances. In the simplest cases of decay of resonance from 70 with spins ½ on nucleons and pseudoscalar mesons a ratio is adduced for amplitudes with free polarization of particles, which does not contradict the experimental data. (auth)

9831 QUADRATIC MASS FORMULAS FOR BARYONS. Soln, J. (Univ. of California, Los Angeles). Nuovo Cimento (10), 46A: 698-706(Dec. 21, 1966).

The three quadratic mass formulas for baryons are derived in broken SU_3 symmetry. They are in quite favorable agreement with experiments. (auth)

9832 THE $D_{\frac{1}{2}}$ MESON-BARYON RESONANCES AND BROKEN UNITARY SYMMETRY. Wong, T. C. (Oxford Univ.). Nuovo Cimento (10), 46A: 583-623(Dec. 21, 1966).

The multichannel ND^{-1} method is applied to the problem of scattering of pseudoscalar mesons (P) by baryons (B) in the $J^P = {}^3/_2{}^-$ state, and in the six SU_3 representations ([8] × [8] = [1] + [8_1] + [8_2] + [10] + [$\overline{10}$] + [27]) involved. The BP system is coupled strongly to the BPP system, the two mesons in the latter channel being dominated by the vector mesons V. The input forces are those due to the exchange of the $^3/_2{}^+$ decuplet in the elastic (BP → BP) channel and the one-meson exchange for the inelastic (BP → BV) transition. Unitarity, including three particles, is satisfied in solving the integral equations. By the use of the pole approximation for the left-hand singularities the scattering amplitude F_{22}(BP → BP) is explicitly obtained. Calculations are carried out first in the case of exact unitary symmetry; then the physical masses for B and P are introduced in the phase-space and centrifugal barrier expressions so that SU_3 is broken in a specific way. The ratios of coupling constants required in the "potential" matrices are determined from the SU_3 symmetric interaction Lagrangian densities (and also in a simple modified form). The theory has two parameters (which are not arbitrary, and can, in principle, be estimated) which are determined in a consistent manner by fitting the observed masses of the Λ^* (1512) and Y_0^* (1520). This consistency criterion also leads to the conclusion that the experimentally observed Y^* (1520) is predominantly singlet. With SU_3 degenerate masses, the model predicts the existence of four unitary multiplets with $J^P = {}^3/_2{}^-$: a singlet [1] at 1540 MeV, an octet [8] at 1668 MeV, a decuplet [10] and an adjoint decuplet [$\overline{10}$] both at 1920 MeV. With broken SU_3, the singlet moves down to 1520 MeV, and it is identified with the observed Y_0^* (1520). The octet splits into four isomultiplets: Λ^* (1512), Y_0^* (1574), Y_1^* (1739) and Ξ^* (1747), whose masses satisfy the Gell-Mann–Okubo mass formula to better than 1.5%. The calculated decay widths are in reasonable agreement with experiment. The D/F ratio for the BP coupling to the $^3/_2{}^-$ octet is found to be unity. It appears, however, that mixing between different unitary multiplets is not correctly described by this model. (auth)

9833 SOME RELATIONS BETWEEN COUPLING CONSTANTS IN HIGHER SYMMETRIES. Patera, J. (Univ., Montreal). Nuovo Cimento (10), 46A: 637-48(Dec. 21, 1966).

A simple Lie group G is assumed to be the group of invariance of a Yukawa interaction $L = g_B\overline{B}BA$, where multiplet A has the dimension of the Lie algebra H of G and g_B is the coupling constant. The multiplets $\overline{B}$ and B are chosen in such a way that there exists only one linearity independent G-invariant coupling L. A simple Lie subgroup G′ of G is the group of invariance of the Yukawa interactions $L^{(1)}, L^{(2)}, \ldots, L^{(q)}$ forming the interaction L. The relations between the coupling are constant g_B and the coupling constants of the processes $L^{(i)}$ which have the structure $L^{(i)} = g_B^{(i)}\overline{B}^{(i)}B^{(i)}A'$, where A′ has the dimension of the Lie algebra H′ of the group G′. (auth)

9834 DENIAL OF SU(3) SYMMETRY IN STRONG INTERACTIONS. Zeldovich, Ya. B. JETP Lett. (USSR) (Engl. Transl.), 4: 257-9(Nov. 1, 1966).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Redaktsiyu, 4: 381-4(Nov. 1, 1966).

The point of view that quarks exist, but there is no similarity or symmetry between the strange λ quark and the p and n quarks is formulated. The basis for this point of view is an analysis of the masses of the mesons and baryons which leads to the conclusion that the spin-spin interaction between λ and p or n is smaller than the spin-spin interaction between p and n by a factor of almost 1.7. (J.F.P.)

9835 DYNAMICAL THEORY OF QUARKS AND STRONG INTERACTIONS. Rayski, Jerzy (Middle East Technical Univ., Ankara). Nucl. Phys., 87: 597-604(1966).

Combining Yukawa's idea of nonlocal fields with Heisenberg's idea of a fundamental nonlinear interaction, a nonlocal, nonlinear theory of SU(3) symmetric quarks and their interactions is formulated. The particle model is no more a material point but an

oscillator. Symmetry-breaking interactions are interpretable as a result of splitting the interaction into a longitudinal and transverse part. There appears an interesting possibility of describing simultaneously quarks and leptons by a set of three fundamental nonlocal fields. (auth)

Quantum Field Theories

Refer also to abstracts 9692, 9736, and 9865.

9836 (JINR-P2-3038) ISSLEDOVANIE URAVNENIYA DLYA FUNKTSII GRINA V NERENORMIRUEMOI TEORII. (Investigation of the Green Function Equation in a Nonrenormalized Theory). Litvinenko, L. G. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1966. 10p. (In Russian). Dep. mn.

Renormalized Dyson equation is investigated by the peratization method in the ladder approximation for the case of scalar particles and massive vector particles interaction. (auth)

9837 (JINR-P2-3040) KVANTOVAYA TEORIYA SKALYARNOGO POLYA S NESTATICHESKIM ISTOCHNIKOM. (Quantum Theory of Scalar Field with Nonstatic Source). Shirokov, M. I. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1966. 18p. (In Russian). Dep. mn.

It is shown that the physical vacuum and real meson are not described by in-out states in the case of scalar field interacting with nonstatic source. After the physical vacuum vector and the real meson annihilation-production operator are defined the Fock amplitudes, defined by means of them, are introduced. The reformulation of the theory in terms of these amplitudes leads to an equation which essentially differs from the initial Schrödinger equation. (auth)

9838 SOME COROLLARIES OF GOLDSTONE'S THEOREM. Gupta, S. N. (National Physical Lab., New Delhi). Nuovo Cimento (10), 46A: 774-7(Dec. 21, 1966).

Some corollaries of Goldstone's theorem on broken symmetries and massless particles are presented. (L.B.S.)

9839 MASS GAP AND VIOLATION OF DISCRETE SYMMETRIES IN QUANTUM FIELD THEORY. Strocchi, F. (Princeton Univ., N. J. Summer Inst. for Theoretical Physics, Boulder, Colo.). Phys. Rev., 152: 1505-7(Dec. 23, 1966).

A Goldstone-like theorem is proved in the case of discrete symmetries: If P is a discrete symmetry satisfying a symmetry-breaking condition, one has to choose between the following possibilities. (i) P is described by a unitary operator. Then there cannot be a mass gap in the energy spectrum. (ii) The energy spectrum has a mass gap. Then P cannot be described by a unitary operator. Actually, P must have nonvanishing matrix elements between the vacuum and some physical states with nonzero energy. The above results have strong implication as far as P, C, CP, etc., are concerned because their violation implies a symmetry-breaking condition and the above theorem applies. (auth)

9840 SCHROEDINGER SECOND QUANTIZATION. I. FUNDAMENTALS. Goedecke, G. H. (New Mexico State Univ., University Park). Phys. Rev., 152: 1120-9(Dec. 23, 1966).

A Hamilton-Jacobi theory, based on a Lorentz scalar Hamiltonian function, is developed for first-quantized relativistic fields. Following Schrödinger's original method for the analogous classical-mechanics formulation, the new Hamilton-Jacobi equation is regarded as the short-wavelength limit of a new wave equation. In the new wave equation, the fields themselves appear as independent coordinates; e.g., in the treatment of three scalar fields, the current density goes over into a current operator which is the "z component of angular momentum" operator in the three-dimensional space of these fields. The scalar Hamiltonian function becomes an operator whose eigenvalues are tentatively identified with particle rest masses. A treatment of interacting scalar Maxwell fields indicates that the new wave equation may allow simple calculations of mass shifts due to interactions, as well as transition quantum numbers, selection rules, and lifetimes. It is shown that the commutators of this theory are essentially the same as "integrated" quantum-field-theory commutators. The interpretation in terms of mass spectra is regarded as inconclusive, primarily because a treatment of the Dirac spinor field has yet to be made. (auth)

9841 CHARACTERISTIC STATES OF THE ELECTROMAGNETIC RADIATION FIELD. Miller, M. M.; Mishkin, E. A. (Polytechnic Inst. of Brooklyn). Phys. Rev., 152: 1110-4 (Dec. 23, 1966).

It has been argued that the positive-frequency part of the quantized electromagnetic field is the "observable" that one would most naturally associate with field measurements using quantum photodetectors. However, since it is possible in principle to make field measurements via the process of stimulated emission, the question of the possible solutions of the characteristic-value equation for the creation operator a† is examined. Various proofs are given to demonstrate that the characteristic kets of a† are not physically admissible states of the radiation field. The possible existence of other useful basis states besides $|n\rangle$, $|\alpha\rangle$, and states generated from these by unitary transformations is then considered. It is shown that when certain restrictions are placed on the correspondence between Hermitian combinations of the arbitrary non-normal operators b and b† and the harmonic-oscillator variables x, p, and H, then the only possible basis states are the coherent states $|\alpha\rangle$ and the number states $|n\rangle$. A λ-dependent variation on the photon annihilation operator a is also considered. Its characteristic states for $-1 \leq \lambda \leq 1$ are derived, and shown to form a complete set. (auth)

9842 BOUNDARY CONDITIONS OF FEYNMAN PATH INTEGRALS. Lam, C. S. (McGill Univ., Montreal). Nucl. Phys., 87: 549-55(1966).

Feynman path integral expressions for transition matrix elements between bare vacua are derived for scalar and spinor fields. Proper boundary conditions are used to avoid the usual somewhat artificial iε prescriptions. (auth)

9843 QUANTUM ELECTRODYNAMICS AND THE CORRESPONDENCE PRINCIPLE. Stehle, P.; DeBaryshe, P. G. (Univ. of Pittsburgh). Phys. Rev., 152: 1135-9(Dec. 23, 1966).

The application of the Bohr correspondence principle to quantum electrodynamics is considered, taking into account the existence of the scattering of light by light and of intensity-dependent radiative corrections. When the effect of the latter is allowed for, the discrepancy between completely quantum-mechanical and completely classical calculations of Thomson scattering is removed. (auth)

9844 REMARKS ON THE EQUAL-TIME COMMUTATOR OF AXIAL-VECTOR CURRENT COMPONENTS. Dietz, Klaus (Univ. of Illinois, Urbana). Contract 1834(05). Phys. Rev., 152: 1306-10(Dec. 23, 1966).

The matrix element of the equal-time commutator of the axial-vector current and its fourth component between one-nucleon states of the same momentum is investigated on the basis of general principles. The dependence of the pion four-momentum of Adler-Weisberger-type relations for the renormalization of the axial-vector coupling constant is examined. Furthermore, the connection of position space singularities with subtractions in the scattering amplitudes involved is shown. (auth)

9845 GREEN'S FUNCTIONS FOR ROTATIONALLY SYMMETRIC MODELS. Abarbanel, H. D. I. (Princeton Univ., N. J.); Klauder, J. R.; Taylor, J. G. Phys. Rev., 152: 1198-1206(Dec. 23, 1966).

Some conventional aspects of certain model theories based both on traditional field equations and on previous solutions obtained by unconventional means are discussed. It is shown that the conventional approach, as the cutoff necessary to define it is removed, cannot reproduce the no-cutoff results of the unconventional approach, nor can any meaningful limit emerge unless the interaction vanishes. The no-cutoff results permit explicit solutions in the lowest "sectors" of Hilbert space and allow for a discussion of renormalization constants, two-point functions, and analyticity of the eigenvalues in the coupling constants: that is, the validity of a certain perturbation expansion. The presence of two asymptotic "one-particle" states is noted and discussed. Finally, brief comments are made on the failure of the conventional field equations, and the relevance of reducible representations of the canonical commutation relations for problems in quantum field theory. (auth)

9846 PARTICLES WITH IDENTICAL QUANTUM NUMBERS IN DISPERSION THEORY AND FIELD THEORY. Kang, Kyungsik (Brown Univ., Providence). Contract AT(30-1)-2262. Phys. Rev., 152: 1234-43(Dec. 23, 1966). (NYO-2262TA-130).

The general structure of the scattering amplitude is expressed in terms of the one-particle reducible and irreducible parts, when there are several particles present having the same quantum numbers in the channel in addition to the physical and unphysical cuts. A comparison with field theory is made to obtain the propagator, the vertex functions, and the matrix of the wave-function renormalization constant Z in terms of the N and D functions of the N/D method by making use of the Lehmann representation of the propagator. The equivalence between composite particles defined in the N/D method and elementary particles with a singular matrix of the wave-function renormalization constant is then proved, i.e., detZ = 0 in the full field theory under the approximation of keeping only up to the two-particle intermediate states. It is also shown that Z becomes singular when the one-particle reducible part A(s) of the scattering amplitude does not decrease as fast as s^{-1} at high energies, i.e., $B \equiv -\lim_{s\to\infty} s^{-1} A^{-1}(s) = 0$. In particular, the condition

B = 0 so that detZ = 0 makes all particles to become composites of other particles, while B ≠ 0 but with detZ = 0 allows mixture of the elementary and composite states. The one- and two-particle cases are discussed in detail to illustrate the compositeness condition detZ = 0. (auth)

9847 SOME PROBLEMS OF AXIOMATICS IN THE ZACHARIASEN MODEL. Astakhov, A. V.; Sukhanov, A. D. (Karpov Inst. of Physics and Chemistry, USSR). Yadern. Fiz., 4: 1083-90 (Nov. 1966). (In Russian).

Solutions of the Heisenberg equations in the Lagrange formulation of the Zachariacen model are obtained. They lead to Hermitean asymptotic fields, satisfying the asymptotic condition. It is shown that although the microcausality condition is satisfied in the model, the Heisenberg operators of fields with continuous mass are nonlocal. It is also established that in this case the S-matrix reduces to a phase operator. (auth)

9848 VELOCITY OF ELECTROMAGNETIC RADIATION IN QUANTUM ELECTRODYNAMICS. Shirokov, M. I. (Joint Inst. for Nuclear Research, Dubna, USSR). Yadern. Fiz., 4: 1077-8 (Nov. 1966). (In Russian).

A problem in quantum mechanics is considered, leading to the possibility of superluminary velocities in quantum electrodynamics. However it is not excluded that a more exact consideration will restore causality in this theory. (auth)

9849 FORMAL DECOUPLING OF S OPERATORS IN QUANTUM ELECTRODYNAMICS. Ziesche, P. (Paedagogische Instituts, Dresden). Acta Phys. Acad. Sci. Hung., 21: 219-27 (1966). (In German).

The known closed representation for the propagator was derived as a formal solution of the Schwinger functional differential equation by means of the formal coupling of the S operator. Perturbation theory was not used. (tr-auth)

9850 A COMMENT ON THE GENERALIZED QUANTIZATION METHOD OF OKAYAMA AND OF ROMAN AND AGHASSI. Kamefuchi, S. (Tokyo Univ.). Nuovo Cimento (10), 45B: 276-9(Oct. 11, 1966).

A discussion of methods for generalizing field quantization and statistics is given, and relations between these methods is clarified. For this purpose the quantum mechanics of a simple harmonic oscillator and a nonrelativistic Schroedinger field are considered. (J.F.P.)

9851 FURRY REPRESENTATION OF CHARGED SCALAR AND VECTOR MESONS. Kimel, Jacob Daniel Jr. Madison, Wis., Univ. of Wisconsin, 1966. 82p.

Thesis.

The electromagnetic interactions, including a static external field interaction, of charged scalar mesons and of charged vector mesons having an arbitrary anomalous magnetic moment are developed in the Furry representation. The systems are transformed from the Heisenberg representation into the Furry representation by application of the Yang–Feldman formalism. The field operators are quantized according to Peierls' method. For both the scalar meson and vector meson problems the interaction Hamiltonian and various contractions in the Furry representation are found to include noncovariant terms. These terms are shown to cancel all orders of e in the generation of the Furry S-matrix for the scalar meson case and to cancel for the vector meson problem except for a noncovariant, singular term of the interaction Hamiltonian. A discussion of the elimination of this term from the vector meson theory by the ξ-limiting process or by the addition of a moment-moment interaction to the interaction Lagrangian density is included. (Dissertation Abstr.)

Scattering Theory

Refer also to abstracts 9810 and 9844.

9852 A SEPARABLE SOLUTION OF THE N/D EQUATIONS. Smith, J. (Univ. of Adelaide). Nuovo Cimento (10), 46A: 770-3 (Dec. 21, 1966).

A solution of the N/D equations for partial-wave scattering amplitudes is proposed which reduces the N/D equations to a set of linear equations. The solution can be made as exactly as needed by increasing the order of the set of equations, and the coefficients are determined by ordinary quadratures. The full solution to the N/D equations is independent of any subtraction point, and no dependence on arbitrary parameters exists. (L.B.S.)

9853 ANALYTIC CONTINUATION OF THE RESOLVENT KERNEL AND SCATTERING OPERATOR ASSOCIATED WITH THE SCHROEDINGER OPERATOR. Dolph, C. L.; McLeod, J. B.; Thoe, D. (Univ. of Michigan, Ann Arbor. Oxford Univ. Purdue Univ., Lafayette, Ind.). Contract DA-11-022-ORD-2059. J. Math. Anal. Appl., 16: 311-32(Nov. 1966).

Some fundamental facts from the general theory of functional analysis is applied in order to study the analytic properties of the resolvent kernel and the scattering operator associated with the Schroedinger operator $A = -\Delta + M(q)$. Here Δ denotes the Laplacian in 3-dimensional Euclidean space, while M(q) denotes the operation of multiplication by the real-valued potential function q(x), i.e., $M(q)\,f(x) = q(x)f(x)$, $x \in E_3$. The method is constructive in nature and provides a basis for developing computational procedures for scattering problems. The continuation of the resolvent kernel and the scattering operator is discussed and three illustrative examples are given. (W.D.M.)

9854 GRAPHICAL METHODS IN ANGULAR MOMENTUM THEORY. Shelepin, L. A. (Lebedev Inst. of Physics, Moscow). Yadern. Fiz., 4: 1091-6(Nov. 1966). (In Russian).

A formulation of the angular momentum theory, making it possible to obtain a number of new relations, is suggested on the basis of the Regge symmetry. The j symbols and operations over them are written in a unified standard way. A corresponding graphical method is suggested. The Wigner coefficient $\begin{pmatrix} j_1 & j_2 & j_3 \\ m_1 & m_2 & m_3 \end{pmatrix}$ is represented by four lines, originating in a single point. Three of them correspond to the m projections and one to the triad $(j_1\ j_2\ j_3)$. Any formulas for the jm symbols can be represented by combinations of such graphs. A connection with the Feynman graph method is noted. (auth)

9855 RESONANCE SCATTERING OF SLOW PARTICLES BY A NONCENTRAL POTENTIAL. Zhizhimov, L. A. (Inst. of Physics and Mathematics, Academy of Sciences, Kirgiz SSR). Yadern. Fiz., 4: 1079-82(Nov. 1966). (In Russian).

A generalization of the Wigner formula to a noncentral potential is obtained for the case when a state with a near-to-zero energy level exists. (auth)

9856 FORMAL THEORY OF MULTICHANNEL REARRANGEMENT COLLISIONS. Chen, Joseph C. Y. (Joint Inst. for Laboratory Astrophysics, Boulder, Colo. Univ. of California, San Diego, La Jolla). Contract DA-31-124-ARO-D-257. Phys. Rev., 152: 1454-9(Dec. 23, 1966).

A general formulation for rearrangement collisions using projection-operator techniques is presented. This formulation is suitable both for multichannel direct and for multichannel resonant reactions in which intermediate compound states are formed. A method for the construction of projection operators is discussed, and explicit expressions of the projection operators are derived for general three-body rearrangement collisions. (auth)

9857 SUPERPERTURBATION THEORY FOR SCATTERING. Blankenbecler, R. (Univ. of California, Santa Barbara). Phys. Rev., 152: 1471-4(Dec. 23, 1966).

A new type of perturbation theory for scattering is developed which has the property that the next term in the series is of the order of the square of the preceding term. It is therefore a perturbation theory which is stationary at each stage. A new variational principle for the phase shift is discussed, which should be more accurate than standard formulations. (auth)

9858 FADDEEV EQUATIONS WITH INELASTIC PROCESSES. Kreps, R. E.; Nath, P. (Univ. of Pittsburgh). Phys. Rev., 152: 1475-86(Dec. 23, 1966).

Starting from the general Lippmann-Schwinger equation, the effect of inelastic processes on the scattering of three-body states is studied. It is shown that it is possible to incorporate the inelastic effects into Faddeev-type equations in two different ways. The first approach is a straightforward generalization of the single-channel Faddeev equations to the multichannel form. However, the concepts of position and particle labeling in order to obtain a meaningful generalization are introduced. The second approach, which is derived from an extension of the concept of a complex potential, yields single-channel Faddeev equations with a modified input. The essential difference between this input and the input for the elastic case is the presence of a completely connected term. The two approaches are shown to be equivalent in their common region of validity. Under the resonance approximation, both approaches yield one-dimensional equations. The structure of the completely connected term is investigated for certain specific models and further simplifications on it are obtained. It is also observed that the concept of the inelasticity parameter in the two-body case does not seem to have a natural generalization. (auth)

9859 KINEMATIC SINGULARITIES OF PARTIAL-WAVE SCATTERING AMPLITUDES. Franklin, Jerrold (Univ. of California, Livermore). Contract W-7405-eng-48. Phys. Rev., 152: 1437-41(Dec. 23, 1966). (UCRL-70038).

Those singularities (and zeros) introduced by partial-wave pro-

jection of unequal-mass scattering amplitudes are investigated. The particular points discussed are: (1) Threshold zeros, especially at the crossed threshold. It is found that unitarity corrections vanish like $k^{L+L'}$ at the crossed as well as the direct threshold, and thus it is appropriate to associate $k^{L+L'}$ behavior of the amplitude with both thresholds. (2) The limit as $s \to 0$ is related to the backward asymptotic behavior in the crossed u and t channels. The partial-wave amplitude goes like $s^{-\alpha}$ for all L as $s \to 0$, where α is the asymptotic power of the crossed-channel backward amplitudes. In Regge-pole theory, this would be leading direct-channel Regge trajectory. (3) Spin effects are shown to lead to $\sqrt{s}$ singularities for bosons as well as fermions. Generalized Mac-Dowell relations are derived, relating negative-energy amplitudes to positive-energy amplitudes for any spin and determining the conditions under which there will be singularities. (auth)

9860 EXTINCT GHOSTS IN POTENTIAL THEORY. Gross, David J.; Kayser, Boris J. (Univ. of California, Berkeley). Phys. Rev., 152: 1441-9(Dec. 23, 1966).

To resolve the difficulties that arise if the P and/or P' Regge trajectories pass through J = 0 at a negative value of the center-of-mass energy squared, Chew has conjectured that the determinant of the physical D matrix does indeed vanish, but that the N matrix is such as to lead to vanishing residues at the pole. It is investigated whether this phenomenon of a simultaneous zero of the N and D functions can occur in potential theory. Standard arguments exclude this possibility for sufficiently well-behaved potentials. However, it is easy to explicitly construct amplitudes which do involve a coincident zero. Using the Gel'fand-Levitan-Marchenko equations, a representation is derived for the potential in terms of the Fredholm determinant of the integral operator that appears in the N/D equations. It is shown that if the s-wave amplitude has coincident zeros, the corresponding potential behaves like $1/r^2$ near the origin; conversely, such potentials give rise, in general, to coincident zeros. However, these zeros are unrelated to any Regge trajectory, so that (except perhaps for potentials which diverge more strongly than $1/r^2$ at the origin) the phenomenon hypothesized by Chew cannot occur in potential theory. (auth)

9861 THRESHOLD BEHAVIOR OF PARTIAL-WAVE SCATTERING AMPLITUDE. Jin, Y. S. (Brown Univ., Providence). Contract AT(30-1)-2262. Nucl. Phys., 87: 578-80(1966). (NYO-2262TA-128).

Using the analytic properties of the scattering amplitude in the $\cos\theta$ plane which were derived in the axiomatic field theory, the threshold behavior of the elastic scattering phase shift $\delta_l \approx k^{2l+1}$ is proved. An additional assumption was made to exclude the threshold bound state. (auth)

9862 BOUND-STATE SCATTERING IN A LEE-MODEL-TYPE FIELD THEORY. Jaffe, A. I.; Reiner, A. S. (Weizmann Inst. of Science, Rehovoth, Israel). Phys. Rev., 152: 1304-6 (Dec. 23, 1966).

A Lee model for bound-state scattering is shown to be exactly soluble in terms of three coupled linear integral equations. Those are similar to the Lovelace equations obtained in a potential theory with separable potentials. (auth)

9863 HIGH-ENERGY BEHAVIOR OF THE SCATTERING AMPLITUDE IN THE UNPHYSICAL REGION $0 < t < 4m^2$. Kinoshita, Toichiro (Cornell Univ., Ithaca, N. Y.). Phys. Rev., 152: 1266-8 (Dec. 23, 1966).

It is proved within the framework of axiomatic field theory that the scattering amplitude must have a Regge behavior in the unphysical region $0 < t < 4m^2$ in the sense that the logarithmic derivative of the absorptive part is bounded by C lns for very large s. (auth)

9864 UNCOUPLED-PHASE METHOD WITH MANY PERTURBING CHANNELS. Kreps, R. E.; Nath, P. (Univ. of Pittsburgh). Phys. Rev., 152: 1249-53(Dec. 23, 1966).

The uncoupled-phase method is a nonperturbative formalism which describes the influence of any given (nth) channel on the dynamics of an n-channel scattering reaction. The method relates scattering amplitudes for the uncoupled reaction, obtained by switching off interactions to the nth channel while the interactions among the rest remain unchanged, to the scattering amplitudes describing the full reaction. The uncoupled-phase method is extended further, under exactly the same assumptions used to derive the previous uncoupled phase relations. The restriction that there is only one perturbing channel is removed and the possibility is considered of an arbitrary number of perturbing channels. The more general set of uncoupled-phase relations reduces to the previous uncoupled-phase relations when the number of perturbing channels is equal to 1. Some elementary applications of these relations is made, and their possible application in elementary particle reactions is indicated. (auth)

9865 THRESHOLD BEHAVIOR OF PARTIAL-WAVE AMPLITUDES IN QUANTUM FIELD THEORY. Roepstorff, Gert; Uretsky, J. L. (Argonne National Lab., Ill.). Phys. Rev., 152: 1213-18(Dec. 23, 1966).

It is shown within the framework of Wightman field theory and the Haag-Ruelle scattering theory that the inelastic partial-wave amplitude for a scattering with two particles in the initial or final state has the classic threshold behavior $T \sim j^l$ and under additional assumptions the phase shifts for elastic scattering obey $\sin\delta_l \sim k^{2l+1}$ in the low-energy limit. (auth)

9866 ZEROS OF THE PARTIAL-WAVE SCATTERING AMPLITUDE. Jin, Y. S.; Kang, Kyungsik (Brown Univ., Providence). Contract AT(30-1)-2262. Phys. Rev., 152: 1227-33(Dec. 23, 1966). (NYO-2262-115).

Under the general assumptions of analyticity, unitarity, temperedness, and normal threshold behavior, the relation between the number of zeros and the high-energy behavior of the partial-wave scattering amplitude is studied. If the left-hand-cut discontinuity makes a finite number of sign changes, the maximum and minimum numbers of zeros can be determined by the high-energy upper and lower bound of the partial-wave respectively. In particular, for $C|s|^{-1+\epsilon} < |f_l(s)| < C$, the number of zeros is determined. After having determined the number of zeros, the number of subtractions as well as the sign of the scattering length is obtained for given number and character of zeros of the left-hand discontinuity $\Delta f_l(s)$. (auth)

9867 ANALYSIS OF THE KOHN VARIATIONAL METHOD. Brownstein, Kenneth Robert. Troy, N. Y., Rensselaer Polytechnic Inst., 1966. 116p.

Thesis.

A variational principle for the scattering problem, equivalent to the Kohn method, is formulated for an abstract vector space. The concept of "asymptotic form" is replaced by that of a "class" of vectors; the latter can be defined purely in terms of an inner product notation. With certain assumptions, it is shown that the variational estimate gives a bound on the exact answer except for very narrow isolated regions of energy. As the trial function is augmented (by including more variational parameters) these narrow regions will get smaller, while in the "good" regions, the variational estimate will approach the exact answer monotonically. The phenomenon observed by C. Schwartz, namely anomalous singularities in the approximate answer, is analyzed in detail as an example. His observations are explained, and evidence is presented to show that the pole strengths of these singularities is much smaller than previously thought. (Dissertation Abstr.)

9868 EXTERNAL FORCE EFFECTS ON PARTICLE REACTIONS. Edwards, Gregg Stanley. Houston, Tex., Rice Univ., 1966. 103p.

Thesis.

The ideas of Trammel & Chalk (TC) are extended so that any type of direct nuclear or peripheral reaction may be calculated as a three-body problem. It shows how the scattering matrix of these reactions may be expressed in terms of the two-particle matrices and simple but complex valued shifts of their energy and angular singularities in an analytic representation. After a brief survey of the main ideas and previous methods the TC formulas are derived in a new and simple manner and their infinite sum over intermediate states is performed by contour integration. A new, iterative method of calculating the corrections to the first approximation is presented such that all the formulas based on the first approximation will retain the same form. This method involves the definition of a "self-consistent" scattering potential which is similar to the definition of the optical potential. Two new expressions for the two particle reaction operator which are suitable for calculation are derived. After a derivation of a generalized distorted wave method and of its connection with the multiple-scattering operators two new, and more nearly exact, approximate methods of evaluating distorted-wave functions are presented. A method of using distorted waves for ease and accuracy in the evaluation of a general rearrangement reaction is presented and the physical significance of each term is discussed. These methods are applied first to deuteron stripping or pick-up with the resulting expression depending explicitly, in this example, upon the n-p scattering matrix and the Jost function of the core potential. This expression could be used to analyze more sensitively the structure of the n-core nucleus since the Jost function varies explicitly with the asymptotic momentum of the deuteron. The second application is to three-body break up. In addition to indicating the shift of two particle resonances due to the other particles and the dependence of the angular distribution upon the resonance structure a more nearly correct generalized density of states function (in the sense of Phillips) and final state enhancement factor (in the sense of Watson) is indicated. The individual terms in the evaluation of the scattering process may

be interpreted as different order of production effects. (Dissertation Abstr.)

9869 METHOD OF CALCULATING REGGE TRAJECTORIES. Blue, James Lawrence. Pasadena, Calif., California Inst. of Tech., 1966. 85p.

Thesis.

A method of calculating Regge trajectories is presented and tested. The method is based on dispersion relations and on Cheng's representation for the S-matrix in terms of the Regge trajectories. A nonlinear equation must be solved to obtain $\alpha(s)$. Potential theory calculations, using the Cheng representation and a modified representation, are made to test the method. To illustrate the application to relativistic scattering, a crude calculation of the rho trajectory is made. A self-consistent trajectory with the experimental mass and width does not exist, but one may be found if the width is about 200 MeV. Omitted physical effects are discussed, and comparison is made with Chew's strip approximation. (Dissertation Abstr.)

Particle Accelerators

Refer also to abstract 9533.

9870 (AERE-R-5328) POLARIZED PROTON TARGET FOR PROTON SCATTERING EXPERIMENTS. Brogden, T. W. P. (Atomic Energy Research Establishment, Harwell (England)). Dec. 1966. 26p. Dep. mn. BIS $0.80. HMSO 4s.

The design and construction are described of a polarized hydrogen target for use in spin correlation studies with incident protons of energies between 70 and 150 MeV. The "solid effect" in lanthanum magnesium nitrate doped with neodymium provided the polarization mechanism in the target. The problems associated with the microwave cavity enclosing the target, especially its cooling requirements, are discussed in detail. Operating experience showed that the target was reasonably convenient and reliable, giving target polarizations of 0.30 to 0.35. Radiation damage in the target crystal due to the incident beam was found to set in very rapidly. (auth)

9871 (BNL-10884) DESIGN STUDY FOR A 1000-MeV BOOSTER SYNCHROTRON INJECTOR FOR THE BROOKHAVEN AGS. Barton, M. Q.; Blewett, J. P.; Courant, E. D.; Maschke, A. W.; Polk, I.; Spiro, J.; Wheeler, G. W. (Brookhaven National Lab., Upton, N. Y.). Dec. 13, 1966. Contract AT(30-2)-Gen-16. 82p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The design study for a 1000-MeV booster synchrotron injector for the BNL AGS is outlined. Topics included are choice of injector synchrotron; choice of injector energy; basis for booster design; booster synchrotron design, including magnet design, injector, lattice structure, magnet power supply, poleface windings, vacuum chamber, rf system, initial betatron acceleration, injection, extraction, phase-space rotation, instrumentation and control, shielding and buildings; possible use of the present AGS linac as injector for the booster; and cost estimates. (B.G.D.)

9872 (BNL-10899) THEORY OF GRADIENT PERTURBATIONS IN THE AGS. Herrera, J. C.; Month, M. (Brookhaven National Lab., Upton, N. Y.). Dec. 8, 1966. Contract AT(30-2)-Gen-16. 17p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Gradient perturbation in the AGS was investigated, basing the development on the equations of motion in matrix form. Explicit expressions for the matrix of the perturbed system to all orders in the perturbing gradient function were derived. Using these expressions the betatron oscillation parameters were obtained to second order in the perturbation. As an illustration, the case of a distribution of point quadrupoles is considered. (B.G.D.)

9873 (JINR-P9-3024-1) ELEKTROSTATICHESKII TRAKT S PERIODICHESKOI FOKUSIROVKOI. (Electrostatic Channel with Periodic Focusing). Glazov, A. A.; Novikov, D. L. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). 1966. 13p. (In Russian). Dep. mn.

The calculation, construction and investigation results of an electrostatic channel with periodic focusing are given. The channel was used to transport the electron beam with the current up to 500 ma at small $\beta = v/c$. The transmission factor is near 0.9. The output beam diameter did not exceed 10 mm. The channel was successively used for transporting pulsed beam with a small value of duty factor and a continuous one to the distance about 600 mm. (auth)

9874 (UCRL-17156) HIGH-GRADIENT DRIFT-TUBE QUADRUPOLE MAGNETS. Main, Robert M.; Haughian, James M.; Meuser, Robert B. (California Univ., Berkeley. Lawrence Radiation Lab.). Sept. 28, 1966. Contract W-7405-eng-48. 14p. (CONF-661021-28). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

From Linear Accelerator Conference, Los Alamos, N. Mex.

A new design for small high-gradient magnetic quadrupoles was devised. This design utilizes a keyed-quadrant yoke-pole configuration which ensures fourfold symmetry of the pole. The coils are tape-wound, occupying the entire slot area and thus minimizing power consumption and cooling problems. The lenses are expected to achieve pole-tip fields in excess of 10 kG and gradients of more than 25 kG/in. for a $\frac{3}{4}$ in. aperture. Methods of winding coils, insulation problems, steel configuration, and cooling schemes are discussed. (auth)

9875 (ORNL-tr-1423) SIMPLE ION SOURCE FOR THE PRODUCTION OF NEGATIVE IONS. Dodeck, H.; Neuert, H. Translated for Oak Ridge National Lab., Tenn., from Z. Naturforsch., 21a: 780-3(1966). 9p. Dep. mn. JCL $1.60 fs, $0.80 mf.

A simple ion source for negative ions is described with which currents of up to 20 μA (O^-, S^-, Cl^-, F^-, C_2H^-) were measured in continuous operation. (B.G.D.)

9876 (SLAC-Trans-54) LIFETIME AND DIMENSIONS OF AN ELECTRON BEAM IN A STORAGE RING. Kulipanov, G. N.; Popov, S. G.; Skrinskii, A. N.; Tumaikin, G. M. (Akademiya Nauk SSSR, Novosibirsk. Institut Yadernoi Fiziki). Translated by T. Watt (Stanford Linear Accelerator Center, Calif.), from Preprint No. 59. 18p. Dep. mn. CFSTI $3.00 cy, $0.65 mn. JCL $1.60 fs, $0.80 mf.

Experimental results and calculated relationships characterizing the behavior of the main parameters of an electron beam in a storage ring at low and high intensities are reported. (auth)

9877 THE SLAC HIGH-ENERGY SPECTROMETER DATA ACQUISITION AND ANALYSIS SYSTEM. Brown, R. M. (Univ. of Illinois, Urbana); Fisherkeller, Mary Anne; Gromme, A. E.; Levy, J. V. Contract AT(04-3)-400. Proc. IEEE (Inst. Elec. Electron. Eng.), 54: 1730-4(Dec. 1966). (SLAC-PUB-205).

One of the experimental stations for the Stanford two-mile Linear Accelerator is equipped with three large magnetic spectrometers for scattered electron analysis. To maximize data collection rates for these, an SDS 9300 computer with a sizable I/O multiplexing capacity was programmed for fast real-time data acquisition and on-line analysis. The system is structured to permit the experimenter to specify his experimental configurations and program requirements in terms of strings of subprograms which can be triggered either by external interrupts, teletype commands, or programmed clocks. The subprograms are symbolically identified and may be either resident or loaded at execution time. A control language for teletype dialog permits flexibility in the description of the desired configuration and mid-experiment editing of the strings of analysis procedures. The data-gathering configuration, the program structure, and the control language of the system are described. (auth)

9878 STABILIZATION OF LONGITUDINAL INSTABILITIES IN STACKING SYSTEMS WITH PHASE-LOCK. Zhilkov, E. A.; Lebedev, A. N. At. Energ. (USSR), 21: 505-6(Dec. 1966). (In Russian).

Previously it was shown that at certain conditions unstable longitudinal density oscillations may develop in an azimuthally homogeneous charged particle beam circulating in the stacking system using an example of, so called, instability of the negative mass; an attempt was made of finding the possibilities for stabilizing the beam by means of electronic phase-lock systems. (tr-auth)

9879 TIME STRUCTURE OF PARTICLE BEAMS EXTRACTED FROM JINR SYNCHROCYCLOTRON. Zinov, V. G.; Medved, S. V.; Ozerov, E. B. At. Energ. (USSR), 21: 445-9 (Dec. 1966). (In Russian).

The time structure of a particle beam extracted from a synchrocyclotron was determined. The time structure which is related to the frequency of the accelerating voltage was found and the absence of a rf structure in the secondary particle beam during slow extraction is shown. (tr-auth)

9880 ACCELERATION OF ELECTRONS IN CIRCULAR PHASOTRON AT LEBEDEV INST. OF PHYSICS. Kazanskii, L. N.; Kanunnikov, V. N.; Kolomenskii, A. A.; Ovcehinnikov, E. P., Papadichev, V. A.; Semenov, S. S.; Fateev, A. P.; Yablokov, B. N. At. Energ. (USSR), 21: 166-76(Sept. 1966). (In Russian).

The design and operating characteristics of the phasotron are discussed. Startup operations and properties of the beam are also considered. (tr-auth)

9881 TRANSVERSE COHERENT INSTABILITY OF BUNCHED CHARGED PARTICLES. Dikanskii, N. S.; Skrinskii, A. N. At. Energ. (USSR), 21: 176-9(Sept. 1966). (In Russian).

The instability of a cluster of charged particles caused by the finite conductivity of accelerator walls is discussed. (tr-auth)

9882 NEW ZEALAND INSTITUTE OF NUCLEAR SCIENCES' 3 MeV ACCELERATOR. Bargh, K. A. (DSIR, Lower Hutt, New Zealand). New Zealand Sci. Rev., 24: No. 1, 5-7 (1966).

The history of the New Zealand Institute of Nuclear Sciences is summarized and a description is given of the operation and features of the 3 MeV Van de Graaff accelerator being installed by the Institute. (auth)

9883 1.5 GeV ELECTRON SYNCHROTRON AT THE POLYTECHNIC INSTITUTE OF TOMSK. Vorobev, A. A.; Volkov, M. N.; Vlasov, A. G.; (and others). At. Energ. (USSR), 21: 435-9 (Dec. 1966). (In Russian).

The design and performance of a 1.5-GeV weak-focusing synchrotron with a magnetic field damping index of n = 0.58 is described. The synchrotron operates with a frequency of 1 Hz and a 5.5 MeV microtron injector. Electron acceleration up to 1.5 GeV requires 2 resonators for producing 240 kV. In 1965 operations with one resonator achieved an energy of 1.1 GeV and acceleration of 1.2×10^{10} particles. (tr-auth)

9884 300 MeV ELECTRON SYNCHROTRON AT THE POLYTECHNIC INSTITUTE OF TOMSK. Anokhin, V. P.; Vlasov, A. G.; Vorobev, A. A.; (and others). At. Energ. (USSR), 21: 502-3(Dec. 1966). (In Russian).

Descriptions are given of a 300 MeV electron synchrotron put into operation on March 1966. The synchrotron with electron injection at 250 MeV was designed as a prototype for a 1500 MeV synchrotron. The electromagnet consists of four quadrants separated by rectilinear gaps 0.6 m long. The magnets consist of 24 blocks with a C-shaped cross section with outside gaps. The magnet also consists of 14.7 tons of Cu and 1.5 tons of steel. The synchrotron operates with a pulse frequency of 1 Hz. (tr-auth)

9885 LINEAR INDUCTION ACCELERATOR. Anatskii, A. I.; Bogdanov, O. S.; Bukaev, P. V.; Vakhrushin, Yu. P.; Malyshev, I. F.; Nalivaiko, G. A.; Pavlov, A. I.; Suslov, V. A.; Khalchitskii, E. P. At. Energ. (USSR), 21: 439-45(Dec. 1966). (In Russian).

The design and construction of a strong-focusing 3 MeV linear induction electron accelerator operating with pulse currents up to 200 A is described. The tests of one accelerator sector showed an electron current of 180 A at 485 keV and a pulse duration of 0.95 to 0.35 μ sec. (tr-auth)

9886 DETERMINATION OF THE VACUUM SYSTEM FOR A LARGE ACCELERATOR. Rommel, G.; Vienet, R. (CEN, Saclay, Gif-sur-Yvette, France). Vide, 21: 391-5(Sept.-Oct. 1966). (In French).

A method for determining a vacuum system for a large accelerator according to required characteristics and taking into account the possibility of using ion pumps and turbomolecular pumps is given. Also given is an application for the determination of the vacuum system for an electron synchrotron and a proton synchrotron. (auth)

9887 SOME REMARKS ON THE DEVELOPMENT OF THE PUMPING SYSTEM OF SATURN. Rommel, G. (CEN, Saclay, Gif-sur-Yvette, France). Vide, 21: 369-74(Sept.-Oct. 1966). (In French).

Statistics of pumping units and vacuum chamber failures are given. In spite of systematic leaking on some elements necessary to the operation of the synchrotron, the average pressure is maintained below the pressure for which loss of particles occurs by collision on the residual gas molecules. The influence of the oil partial pressure upon these particle losses is studied. From the experience on the vacuum system operation, a few suggestions are made for the selection of materials. (auth)

9888 MEASUREMENT OF PEAK VOLTAGE OF A MICROTRON RESONATOR. Fielitz, K.; Haag, H. W. (Univ., Mainz). Z. Angew. Phys., 22: 26-9(1966). (In German).

Thermionic electrons are accelerated by the rf electrical field of a microtron resonant cavity. The peak rf voltage of the cavity can be calculated from the measured maximum kinetic energy of the accelerated electrons. A discussion is given for the existence of two peaks in the energy distribution curve. A calibration curve was obtained for the dependence of the peak rf voltage of the cavity (300 to 600 kV) from the average power consumption of the cavity (70 to 300 W). The effective shunt resistance of the cavity is calculated from the measured data. (auth)

9889 PROBLEMS OF PUMPING AND THE SOLUTIONS ADOPTED FOR NEW LINEAR PARTICLE ACCELERATORS. Azam, G.; Milcamps, J. (Centre de Physique Electronique et Corpusculaire, Orsay, France). Vide, 21: 380-5(Sept.-Oct. 1966). (In French).

After the development of the various aspects of the vacuum problem in the linear electron accelerators, reasons for the choice of solutions are described. The particular problems are examined concerning the zones where the beam is accelerated where exists a strong rf field and in the zones without an electric field. The description of two new linacs built by the C.S.F. is given. (auth)

9890 VACUUM CHAMBER PROJECT FOR A SYNCHROTRON. Lefebvre, M. J. M. (CEN, Saclay, Gif-sur-Yvette, France). Vide, 21: 386-90(Sept.-Oct. 1966). (In French).

An electron synchrotron vacuum chamber must have a special structure such that it does not distort the magnetic field and that it resists large radiation doses of the order of 10^{11} rads. Different projects were studied, using either glass, or ceramic or stainless steel. Preliminary tests have shown that two solutions only could be retained; two prototypes were accordingly made. Given is a comparison between these two solutions. (auth)

9891 NONLINEAR EFFECTS DURING COHERENT AMPLIFICATION OF SPIN WAVES BY A CHARGED PARTICLE BEAM. Makhmudov, Z. Z. (Inst. of Physics, Academy of Sciences, Azerbaydzhan SSR). Zh. Eksp. Teor. Fiz., 51: 1934-9(Dec. 1966). (In Russian).

Nonlinear effects during coherent amplification of spin waves by a charged particle beam are considered. It is assumed that the amplitude of the amplified wave considerably exceeds the background amplitude. The beam density is assumed to be small. The analysis is performed in the hydrodynamic approximation. The maximum amplitudes of the magnetic moment oscillations of a ferromagnet are estimated. It is shown that the maximal amplitude during amplification related to the Cherenkov effect is proportional to the square of the increment whereas during amplification in the case of the Doppler effect it is proportional to the increment to the $^3/_2$ power. (auth)

9892 STIMULATED TRANSITIONS IN THE RADIATION FROM A RELATIVISTIC ELECTRON IN AN INHOMOGENEOUS MAGNETIC FIELD. Sokolov, A. A.; Zhukovskii, V. Ch.; Korovin, Yu. A. (Moscow State Univ.). Zh. Eksp. Teor. Fiz., 51: 1829-32(Dec. 1966). (In Russian).

Stimulated transitions of relativistic electrons moving in a stationary but inhomogeneous magnetic field are investigated. The region of harmonics variation is found for which stimulated radiation should exceed absorption. (auth)

9893 SOME CHARACTERISTICS OF MEDICAL BETATRONS. Makino, Sumio; Nagai, Katsumi (Tokyo Shibaura Electric Co., Ltd.). Toshiba Rebyu, 21: 1029-34(Oct. 1966). (In Japanese).

Particle accelerators have come to be widely used as sources of high-energy x rays and electron beams in the medical world. Reports on achievements about their clinical application have already been published in large numbers. Some characteristics of the latest medical betatrons are reported. (B.G.D.)

9894 WELDING FABRICATION OF RESONANT CAVITIES OF PROTON LINEAR ACCELERATORS. Kondo, Hiromu; Inamura, Minoru (Mitsubishi Electric Mfg. Co., Ltd., Japan). Mitsubishi Denki Giho, 40: 1579-87(Oct. 1966). (In Japanese).

Cavities used for the proton linear accelerator must meet with very rigid specification from the character of the apparatus. After a good number of building methods have been thought out, a trial was made to weld fabrication a cavity by using 20 mm thick mild steel to which 8 mm oxygen free copper plate is pressure welded by explosion to form copper clad steel. Based on this material a cavity of 2,000 mm long and 1,000 mm in diameter was built and machined with extreme precision. The product was confirmed to serve the purpose through repeated practical acceleration tests. The process of building the cavity and the materials employed are discussed. (NSA of Japan)

9895 STRUCTURE OF A BUNCH OF CHARGE IN AN IDEAL ACCELERATOR. Newton, T. D. (Atomic Energy of Canada Ltd., Chalk River, Ont.). Can. J. Phys., 44: 3137-71 (Dec. 1966). (AECL-2614).

A bunch of charged particles is considered to be moving in a long conducting tube subject to external time-dependent focusing forces. The density of particles in the bunch and the electromagnetic field of the bunch of charge in the conducting tube are simultaneously determined. The parameters of the idealized accelerator may be obtained from those of an actual machine design so that predictions of bunch shape and effects of space and image charges on phase areas (emittances) may be made. (auth)

9896 THEORETICAL INVESTIGATION OF THE STEPPED-FIELD CONFIGURATION USED FOR FOCUSING POSITRON BEAMS. Lobb, D. E. (Saskatchewan Accelerator Lab., Saskatoon). Nucl. Instrum. Methods, 46: 181-93(1967).

The stepped-field configuration for focusing and confining a positron beam in a linear accelerator is analyzed. Two methods of analysis are presented: an analysis based on an idealized con-

cept of a uniform short axial field with a discontinuous transition to a weaker uniform axial field down the remaining length of the accelerator and a numerical ray trace through a field specified by an axial magnetic field plot. It is shown that these two methods agree quite well provided that the actual field after the abrupt transition is reasonably uniform. It is also shown that a nonuniform region after the abrupt transition is undesirable. The system performance as a function of the various system parameters and the emittance acceptance of the downstream beam handling facilities is analyzed. Formulas are presented to calculate the useful source spot size and the optimum shape of the downstream phase space acceptance. (auth)

9897 PARTICLE ACCELERATOR. Matsuyama, Yoshihiko (to Mitsubishi Heavy-Industries, Ltd.). Japanese Patent 1965-23719. Oct. 18, 1965. Filed Mar. 31, 1964.

An improved high-energy particle accelerating device is proposed for use as medical or radiographical devices. By the method proposed, the resultant device can be compact with the relative flexibility permitted in the design of its components, and a high degree of stable focusing is obtainable in the accelerated beam. It consists of the following: the mechanism of linear particle-acceleration, installed in an approximate vertical plane; the device for deflecting about 180° the accelerated beam; and the device for rotating both the mechanism and the device on their horizontal axis. (NSA of Japan)

9898 BETATRON. Seki, Yoshitaka (to Tokyo Shibaura Electric Co., Ltd.). Japanese Patent 1965-23718. Oct. 18, 1965. Filed May 13, 1964.

In the conventional betatrons, because of its single electron gun employed the electron beam injected into the circular accelerating tube is not sufficient, which results in the relatively insufficient production of x rays. This caused the lengthened irradiation (by the x rays) in industrial nondestructive testing or in radiotherapy. In the betatron proposed, to cope with this difficulty more than two electron guns are installed in the betatron, circular (or doughnut-shaped) accelerating tube. It consists of the following: the evacuated circular accelerating tube; at least two electron guns installed in the tube at suitable intervals; the devices for injecting the electrons from the guns at given time intervals; a device for applying the magnetic field for accelerating the beams in their circular orbits; a device for adjusting the injection time to the magnetic field intensity; and a device for adjusting and selectively changing the orbits. The accelerated electron beam is either allowed to impinge upon the target installed in the circular accelerating tube, or it is withdrawn from the tube through its window. (NSA of Japan)

9899 HIGH-FREQUENCY WAVE CHARGED-PARTICLE ACCELERATING DEVICE. Takeda, Yasutsugu (to Hitachi, Ltd.). Japanese Patent 1966-1038. Jan. 28, 1966. Filed Sept. 1, 1964.

An improved high-frequency wave charged-particle accelerating device is proposed in which the fluctuations of both the output beam energy and the current can be held within the tolerable limits. It consists of a charged particle source, and an arrangement of cavity resonators, having a space for the interaction of a charged-particle beam and the high-frequency wave, and the accelerating tubes. The cavity resonator is provided with at least one coupling point for introduction of the high-frequency power, and at least one coupling point for the external load. It is further provided with a charged-particle phase bunching-device in which either the coupling degree of the cavity resonator and the high-frequency power source, or the coupling degree of the cavity resonator and the external load, or both can be changed. (NSA of Japan)

9900 MAGNETIC POLES FOR A BETATRON. Suematsu, Shigeru (to Hitachi, Ltd.). Japanese Patent 1966-1040. Jan. 28, 1966. Filed Sept. 9, 1964.

Improved magnetic poles for a betatron are proposed. An insulating cylindrical body is fixed very tight to the outside of, and surrounding, the magnetic pole, composed of the individual sector-shaped sections; one end of this cylindrical body partly protrudes from the magnetic pole. By this means, the pole can be connected to the yoke very fast, resulting in reduced vibration. When this method was applied to a 15-MeV betatron, the following advantages were found: the adhering powers of the order of 4 kg/cm^2 at both the center and circumference of the magnetic poles; a reduction in the vibration caused by the electromagnetic force; an increase in the production of x rays, from 40 to 100 r/min., at the distance 1m from the target; an increase in the life of the electron-gun filament, from 200 to 500 hrs. (NSA of Japan)

9901 HIGH-VOLTAGE POWER SOURCE CONTROL DEVICE FOR PARTICLE ACCELERATORS. Utsunomiya, Shinhachi (to Tokyo Shibaura Electric Co., Ltd.). Japanese Patent 1966-800. Jan. 26, 1966. Filed Apr. 30, 1964.

In the high-voltage power source control device proposed, the pulses of the input voltage and current at the high-voltage producing circuits for a particle accelerator are made the same, thereby minimizing the capacitance of the input power-source. The particle accelerator, which is energized by the power-supply circuits having a device controlled in the phase by the output of the oscillation circuits, is provided with the following: a transformer for detection of the current phase, connected to the power supply circuits in order to detect the wave-shapes of the voltage and current; a transformer for detecting the phase of the voltage; the circuits for detecting and multiplying the difference in the phases of the voltage and the current by the two transformers; and the control mechanism for adjusting the frequency of the oscillation circuits by a servomoter circuited by the output of detection of the phase difference. By this arrangement, the input voltage and the input current for the particle accelerator are made of the same phase. (NSA of Japan)

9902 DEFLECTOR FOR AN ACCELERATOR. Unino, Yoichi (to Tokyo Shibaura Electric Co., Ltd.). Japanese Patent 1965-23720. Oct. 18, 1965. Filed Dec. 28, 1964.

In the radiotherapeutic device, there is the need for switching from the accelerated beam to the radiation (produced at the target), and vice versa. The deflector proposed was constructed for removing or replacing, in conventional accelerators, the target emitting the radiation (e.g., x-rays) upon exposure to the accelerated beam (e.g., electron beam), as required. It consists of the following: the beam deflector, rotatable on its axis perpendicular to the axis of the accelerated beam; the target upon which the deflected beam impinges; and the device for rotating the beam deflector. (NSA of Japan)

PHYSICS (NUCLEAR)

Neutron Interactions with Matter

Refer also to abstracts 8650, 10005, 10079, and 10201.

9903 (AAEC-E-155) SYNTHETIC KERNELS OF NEUTRON SLOWING-DOWN THEORY AND A RELATED EXPANSION. Wilkins, C. A.; Keane, A. (Australian Atomic Energy Commission Research Establishment, Lucas Heights). June 1966. 13p. Dep. mn.

Various approximate solutions of the integral equation for neutron moderation are obtained by truncating an asymptotic expansion for the collision density, a process which is shown to be equivalent to replacing the scattering kernel by an alternative synthetic kernel which permits "exact" solution of the integral equation. Truncation after one or two terms, and approximation of a constant in one case, yield the classical kernels. It is shown that the appropriate kernel to be used depends on the particular quantity under investigation. In particular, an illustration is given showing why the Wigner kernel is superior to that of Goertzel and Greuling for calculating resonance absorption. Difficulties may arise when using the entire non-truncated series. It is shown that, for the sources of practical interest in reactor theory, these difficulties may be removed by splitting the source into two "components," one rapidly decaying and the other not. When the source is not known sufficiently accurately for this splitting to be done, the series must, in general, be truncated to avoid divergence. The method of obtaining a kernel by truncation is consistent with the matching of moments method. (auth)

9904 (AEEW-R-489) CALCULATION OF RESONANCE CAPTURES IN A FEW-GROUP APPROXIMATION. Askew, J. R. (Atomic Energy Establishment, Winfrith (England)). June 1966. 23p. Dep. BIS $0.80. HMSO 4s.

The theory of few-group treatment of resonance captures is expounded, and appropriate methods for the spatial and energy averaging of cross sections are derived in a form that is suitable for machine computation–i.e., as material cross sections which can be used directly in a neutronics code. The method treats both self and mutual shielding of resonances (the latter, interaction with other nuclides, by an approximate method) in geometries ranging from homogeneous mixtures through regular rod arrays to clustered fuel assemblies and includes the effect of spatial source distribution, for example between moderator and coolant in pressure-tube configurations. A particular application of the method was to the lattice calculation code WIMS, and a sample 10-group library of data for ^{238}U and ^{235}U as used in this code is included. (auth)

9905 (BNWL-307) NEW ANALYTICAL RESULTS FROM SLOWING-DOWN THEORY, AND THEIR APPLICATION TO A CHECKOUT OF THE RBU SLOWING-DOWN ROUTINE. Gibbs, A. G.; Thomsen, D. H. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Nov. 1966. Contract AT(45-1)-1830. 11p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The analytical results are compared to Monte Carlo calculations done using the RBU slowing-down routine. The comparison indicates that the routine is working properly. (auth)

9906 NEUTRON FLUX DISTRIBUTION THROUGH A RESONANCE. Dyos, M. W. (General Atomic Div., General Dynamics Corp., San Diego, Calif.); Keane, A. Nucl. Sci. Eng., 26: 288(1966).

The qualitative behavior of the second-order neutron flux for a strongly scattering resonance in a dilute system is briefly discussed. It is shown that in the shift of the flux minimum to energies above the resonance energy, the flux can rise above its off-resonance value in the vicinity of one collision interval below the resonance center. (S.F.L.)

9907 EFFECTIVE THERMAL-NEUTRON CROSS SECTIONS FOR MATERIALS WITH GRAIN STRUCTURE (ADDENDUM). Dyos, M. W. (General Atomic Div., General Dynamics Corp., San Diego, Calif.). Nucl. Sci. Eng., 26: 288(1966).

An addendum is given to a previous publication [Nucl. Sci. Eng., 25: 1, 8(1966)] on a method for calculating the effective thermal neutron cross sections for spherical fuel grains dispersed throughout a moderator. The addendum concerns the use of the correct forms of shielding factors, depending upon the sizes of the fuel grains with respect to the associated cell. (S.F.L.)

9908 EVALUATION OF RESONANCE INTEGRAL CORRECTION FACTOR. Itkin, I. (Westinghouse Electric Corp., West Mifflin, Pa.). J. Nucl. Energy: Pt. A and B, 20: 977-8 (Nov.-Dec. 1966).

The mesh dependence of the multiplicative correction factor that is applied to Dresner's resonance integral formula to take into account the chi-squared distribution of neutron widths is studied. (D.C.W.)

9909 STEADY-STATE NEUTRON SPECTRA IN BERYLLIUM. Grover, P. S.; Ahmed, F. (Univ. of Delhi). J. Nucl. Energy: Pt. A and B, 20: 979-81(Nov.-Dec. 1966).

The results of some calculations on steady-state neutron spectra in different finite sizes of beryllium assemblies at 100 and 300°K are presented. The effect of increasing absorption on neutron spectra is also studied. (D.C.W.)

9910 TIME-DEPENDENT SPECTRA IN HEAVY WATER. Wydler, P. (Federal Inst. for Reactor Research, Wuerenlingen, Switzerland). J. Nucl. Energy: Pt. A and B, 20: 981-4(Nov.-Dec. 1966).

The spectra of neutrons emerging from the center of a cylindrical tank with a geometric buckling $B^2 = 5.78 \times 10^{-3}$ cm^{-2} were measured between 40 μsec and 1.2 msec after the injection of a fast neutron pulse. Theoretical spectra were calculated using two different kernels in the diffusion approximation. (D.C.W.)

9911 USE OF THE P_n APPROXIMATION TO DESCRIBE THE NEUTRON DISTRIBUTION IN AN ABSORBING ROD. Sergeev, I. V. J. Nucl. Energy: Pt. A and B, 20: 987-92(Nov.–Dec. 1966).

A set of nonlinear differential equations describing the neutron distribution in an absorbing rod in the P_n approximation is transformed into a set of integral equations more convenient for investigation. A method of solutions based on the use of successive approximations is proposed. (auth)

9912 ASYMPTOTIC SOLUTIONS IN TRANSPORT THEORY. PART I. ONE VELOCITY WITH ISOTROPIC SCATTERING. Ghatak, A. K.; Ahmed, F. (Univ. of Delhi). J. Nucl. Energy: Pt. A and B, 20: 939-51(Nov.-Dec. 1966).

Some results are presented of an extensive series of calculations on the asymptotic behavior of a neutron pulse injected into a slab and a sphere using monoenergetic transport theory with isotropic scattering cross section in the laboratory system. These results are compared with the infinite medium solutions with exp (iBx) spatial dependence. Two definitions of buckling are considered and the corresponding extrapolation distances are calculated; both the quantities are of considerable interest in the study of neutron thermalization. The characteristic angular peaking of neutrons leaking from slabs of extremely small thicknesses has been found. The spatial variation of the fundamental mode eigenfunction was calculated and it was found that the flux shape (except very close to the boundary) can be fitted accurately to the fundamental mode of the scalar Helmholtz equation $\nabla^2\Phi + B^2\Phi = 0$. The results obtained from simple diffusion theory, with extrapolation distance assumed to be given by the Milne value, (independent of the size of the assembly), were found to compare well with the exact calculations of the fundamental mode eigenvalue for thicknesses exceeding one mean free path. The theoretical results are compared with the recent pulsed neutron experiments in fast non-multiplying non-moderating assemblies. (auth)

9913 COLD NEUTRON EFFECTS IN GRAPHITE DIFFUSION MEASUREMENTS. DeJuren, J. A.; Swanson, V. A. (Atomics International, Canoga Park, Calif.). J. Nucl. Energy: Pt. A and B, 20: 905-14(Nov.-Dec. 1966).

Diffusion-length measurements were made in AGOT graphite as a function of transverse buckling. For bucklings greater than 3.5×10^{-3} cm^{-2} spectral equilibrium is not attained between a predominantly thermal neutron group and a cold neutron group beyond the Bragg cut-off. The presence of cold neutrons causes a distinct increase in the measured extrapolation length. A treatment is given for the variation of the steady-state diffusion length with buckling for a Maxwellian spectrum whose temperature is modified by leakage. (auth)

9914 WHAT IS FLUX. II. Dessauer, Gerhard (E. I. du Pont de Nemours and Co., Aiken, S. C.). Nucl. News, 10: No. 1, 17-20(Jan. 1967). (TID-22298).

The exploration of the meaning of the term "neutron flux" is continued. Topics discussed are: fast flux, resonance flux and Doppler effect, and flux distribution. It is concluded that a precise definition of what is meant by "flux," in any given case, must include information on some or all of the following subjects: the nuclear reactions considered, the neutron spectrum, the cross section dependence on neutron energy, and the degree of self-shielding of the resonances. (M.H.R.)

9915 WHAT IS FLUX. I. Dessaur, Gerhard (E. I. du Pont de Nemours and Co., Aiken, S. C.). Nucl. News, 9: No. 12, 17-21 (Dec. 1966). (TID-22298).

The meaning of the term "neutron flux" is explored at length. The absolute and relative number of all competing nuclear events in a reactor are dealt with. Topics discussed are: flux and cross section, neutrons of uniform speed, neutrons of all velocities, thermal flux, and the range of thermal flux levels. (M.H.R.)

9916 INFLUENCE OF ROTATIONAL LEVELS ON SLOW-NEUTRON SCATTERING BY LINEAR GASES. Lurie, Norman A. (Univ. of Michigan, Ann Arbor). J. Chem. Phys., 46: 352-6 (Jan. 1, 1967).

Calculations of slow-neutron partial differential scattering cross sections are reported for molecules with linear symmetry in which the quantum-mechanical nature of the rotational levels is taken explicitly into account. The method used is an extension of Griffing's results to nonspherical molecules. The calculations for HF, HCl, N_2, and HCN gases are compared to calculations based on the Krieger–Nelkin approximation, and the failure of the latter method to account correctly for rotational-energy transfers is pointed out. (auth)

9917 RESONANCE SCATTERING NEAR THE THERMAL REGION. Pearson, C. A.; Robertson, I. (Australian Atomic Energy Commission Research Establishment, Lucas Heights, New South Wales). J. Nucl. Sci. Technol. (Tokyo), 3: 437-40 (Oct. 1966).

The effect on the neutron flux, in a homogeneous mixture of moderator and fuel, of scattering from low-energy resonances in the fuel is considered. Particular attention is given to resonances for which slowing-down theory is inappropriate. The kernel for a monatomic gaseous resonance scatterer is derived and is compared with the "slowing down" kernel commonly used. The effects of the two kernels on the flux near the resonance for the particular case of ^{240}Pu and a light moderator are also compared. (auth)

9918 INITIAL-VALUE PROBLEM OF THE TRANSPORT EQUATION FOR A MODERATOR SLAB. Ukai, Seiji (Kyoto Univ.). J. Nucl. Sci. Technol. (Tokyo), 3: 430-6(Oct, 1966).

A mathematical analysis of the time-dependent neutron transport equation is presented for the case of a moderator slab. The scattering of neutrons is treated on the basis of the Van Hove theory and is assumed to be isotropic. First, the spectrum of the corresponding transport operator is investigated, and it is shown that the complex λ-plane is decomposed by the operator into a band spectrum $\mathrm{Re}(\lambda) \leq -(v\Sigma_t)_{\min}$, a discrete spectrum on the real axis $\lambda > -(v\Sigma_t)_{\min}$, and a resolvent set $\mathrm{Re}(\lambda) > -(v\Sigma_t)_{\min}$ deleted by the discrete spectrum. The discrete spectrum is carefully studied and is found to consist of isolated eigenvalues or otherwise empty. For all categories of moderator, there exists an upper limit to the thickness of a slab having empty discrete spectrum. A slab exceeding this limit has a finite number of eigenvalues if the moderator material is gas or solid. This is also true for a certain class of liquid moderators. For other liquids, there is another critical thickness for the slab thickness such that if it is exceeded, the set of eigenvalues turns out to be denumerable with an accumulation point at $-(v\Sigma_t)_{\min}$. Each eigenvalue possesses a finite multiplicity, and the index is one. Finally, the related initial-value problem is considered, and it proves to have a unique solution upon application of the Hille-Yosida theorem. The contribution of the band spectrum to the solution is evaluated and is shown to decay faster than $\exp\{-(v\Sigma_t)_{\min}t\}$. (auth)

9919 SPECTRAL INDICES OF AN INTERMEDIATE ENERGY NEUTRON SYSTEM. Inoue, Kazuhiko; Kanda, Keiji; Nanyjo, Tsutomu (Kyoto Univ.). J. Nucl. Sci. Technol. (Tokyo), 3: 450-2 (Oct, 1966).

Differential and integral indices for the description of intermediate neutron spectra are proposed, and the characteristics of the intermediate neutron spectrum are discussed using these indices. (D.C.W.)

9920 CHARACTERISTIC SPECTRA IN NEUTRON THERMALIZATION. III. IMPROVED BASE FUNCTIONS FOR ORTHOGONAL EXPANSION. Furuhashi, Akira (Tokyo Inst. of Tech.). J. Nucl. Sci. Technol. (Tokyo), 3: 379-87(Sept. 1966).

A study of convergence in the orthogonal expansion method for analyzing time-eigenvalue problems in neutron thermalization was made using several kinds of base functions (orthonormal system). The results confirmed the superiority of the velocity polynomials over the energy polynomials, but demonstrated further that still other base functions can provide convergence even faster than with the velocity polynomials. In particular, a newly developed base in the form of an exponential series in energy offers a convenient tool. Time-eigenvalue problems are analyzed for the cases of proton gas, heavy gas, and heavy Einstein solids, where particularly characteristic spectra are studied in some detail using the new base functions. (auth)

9921 A METHOD FOR SOLVING SPACE-DEPENDENT KINETIC EQUATION FOR ANALYZING PULSED-NEUTRON EXPERIMENTS. Yoshijima, Shigekazu (Nippon Atomic Industry Group Co., Tokyo). J. Nucl. Sci. Technol. (Tokyo), 3: 403-6 (Sept. 1966).

A numerical method is presented for solving the implicit difference equations for the space and time behavior of neutron flux following a burst of neutrons in multiplying media by modifying ordinary static diffusion codes. The technique substantially reduces the computation time as compared with solving the explicit difference equations. (S.F.L.)

9922 SLOW-NEUTRON SCATTERING AND COLLECTIVE MOTIONS IN LIQUID LEAD. Randolph, P. D. (Phillips Petroleum Co., Idaho Falls, Idaho); Singwi, K. S. Phys. Rev., 152: 99-112(Dec. 2, 1966).

The Materials-Testing-Reactor phased-chopper velocity selector was used to make measurements of the scattering law $S(\kappa,\hbar\omega)$ for liquid lead at 352°C for energy transfers $\hbar\omega$ in the range 0 to 20 MeV and for momentum transfer $\hbar\kappa$ in the range 1 to 4 Å^{-1}. The scattering law exhibits a strong momentum-dependent structure at small energy transfer (corresponding to the diffraction maxima). Although for large values of the energy transfer this pronounced structure has disappeared, the $S(\kappa,\hbar\omega)$ curves still show two very broad maxima. The one-phonon partial differential scattering cross section is extracted from the data after subtracting multiphonon and multiple-scattering contributions, and the results are compared with those calculated on the basis of a model proposed by Singwi. This comparison shows that the model not only has the correct qualitative features but also gives a semiquantitative agreement. From the analysis of the data, it is concluded that there exist collective excitations in liquid lead. Also, for times of the order of 10^{-12} sec, there exist at least the first two somewhat diffuse Brillouin zones in the liquid. (auth)

9923 REACTOR PHYSICS IN THE RESONANCE AND THERMAL REGIONS. VOLUME I. NEUTRON THERMALIZATION. Proceedings of the National Topical Meeting of the American Nuclear Society, San Diego, February 7–9, 1966. Goodjohn, A. J.; Pomraning, G. C. (eds.). Cambridge, Mass., Massachusetts Institute of Technology Press, 1966. 430p. $7.50. (CONF-660204).

Papers (18) are presented dealing with atomic motion in moderators, neutron scattering, pulsed-neutron experiments, methods for calculation of thermal-neutron fluxes and spectra, calculation of disadvantage factors, and applications of thermalization theory. (D.C.W.)

9924 REACTOR PHYSICS IN THE RESONANCE AND THERMAL REGIONS. VOLUME II. RESONANCE ABSORPTION. Proceedings of the National Topical Meeting of the American Nuclear Society, San Diego, February 7–9, 1966. Goodjohn, A. J.; Pomraning, G. C. (eds.). Cambridge, Mass., Massachusetts Institute of Technology Press, 1966. 462p. $7.50. (CONF-660204).

Papers (17) are presented dealing with the calculation and measurement of neutron cross sections and resonance parameters, resonance capture in reactor lattices, reactivity effects in fast reactors, neutron cross sections and resonance parameters of fissile nuclides, and Monte Carlo methods for resonance absorption. (D.C.W.)

Nuclear Properties and Reactions, A≤ 5

Refer also to abstracts 9738, 9794, 9827, and 9944.

9925 SEARCH FOR EXCITED STATES OF ^3He. Frosch, R. F.; Crannell, H. L.; McCarthy, J. S.; Rand, R. E.; Safrata, R. S.; Suelzle, L. R.; Yearian, M. R. (Stanford Univ., Calif.). Phys. Lett., 24B: 54-6(Jan. 9, 1967).

A search was made for virtual excited states of ^3He by inelastic electron scattering at E = 200 MeV and $\theta = 60°$. No evidence for narrow states excited with cross section greater than 3×10^{-33} cm^2/sr was found for excitation energies up to 17 MeV. (auth)

9926 A STUDY OF PION CAPTURE BY ^3He. II. REACTIONS INVOLVING NUCLEAR BREAKUP. Zaimidoroga, O. A.; Kulyukin, M. M.; Sulyaev, R. M.; Falomkin, I. V.; Filippov, A. I.; Tsupko-Sitnikov, V. M.; Shcherbakov, Yu. A. (Joint Inst. for Nuclear Research, Dubna, USSR). Zh. Eksp. Teor. Fiz., 51: 1646-53(Dec. 1966). (In Russian).

Pion capture by ^3He resulting in breakup of the nucleus was investigated using a high-pressure diffusion chamber in a magnetic field. The relative probabilities of the processes and the momentum spectra of the secondary charged particles were measured.

The results are compared with the calculations based on the two-nucleon capture model. (auth)

9927 NOTE ON THE EXISTENCE OF THE TRINEUTRON. Okamoto, K.; Davies, B. (Univ. of New South Wales, Kensington, Australia). Phys. Lett., 24B: 18-21(Jan. 9, 1967).

The possibility of a bound trineutron (^{3}n) is investigated by a variational technique, and ^{3}n is found to be unbound. The systematics of the last neutron separation energies also support this conclusion. (auth)

9928 LEVEL STRUCTURE OF MASS-5 AND MASS-3 NUCLEI. Fraser, R. F.; Spicer, B. M. (Univ. of Melbourne). Austral. J. Phys., 19: 893-6(Dec. 1966).

The results of an attempt to explain the energy-level structure of nuclei with A = 3 and 5 in the framework of the particle-hole model are presented. (D.C.W.)

9929 A FEW USES OF ELEMENTARY PARTICLES IN NUCLEAR STRUCTURE STUDIES. Wilkinson, D. H. (Nuclear Physics Lab., Oxford). Acta Phys. Acad. Sci. Hung., 21: 255-76 (1966).

A selective review is given of some of the ways in which elementary particles and the techniques of high-energy physics in general may be used for the investigations of nuclear structure. It is pointed out that the ability to extract new nuclear structure information from such experiments is often limited by ignorance of other aspects of nuclear structure. (auth)

Nuclear Properties and Reactions, $6 \leq A \leq 19$

Refer also to abstracts 9814, 9827, 9929, 9956, 9977, 9984, 10075, 10091, 10101, and 10119.

9930 (ANL-7247) PHYSICS DIVISION SUMMARY REPORT, JUNE-AUGUST 1966. (Argonne National Lab., Ill.). Contract W-31-109-eng-38. 61p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Neutron angular distributions and polarizations in neutron scattering by ^{19}F at energies between 0.2 and 2.2 MeV were measured. The data are consistent with the interpretation of the observed intermediate structure in terms of doorway states and lead to an assignment of spins and parities to these states. Using the metastable 8$^-$ state as an example, it was also demonstrated that nuclear systematics in deformed nuclei can sometimes be used to set an upper limit on possible parity mixing. A mass spectrometer was used to study the photoionization of alcohols, alkanes, high-temperature vapors, and the CF_3 and CH_3 radicals. The reactions of H_2^+ and O_2^+ with He and H_2 were also studied using photoexcitation of different electronic and vibrational states of the reacting ions. (D.C.W.)

9931 (BMwF-FBK-66-26) ANREGUNGSFUNKTIONEN UND WINKELVERTEILUNGEN DER REAKTION ^{7}Li(p,γ)^{8}Be. (Excitation Functions and Angular Distributions of the Reaction ^{7}Li(p,γ)^{8}Be). Riech, V. (Bundesministerium fuer Wissenschaftliche Forschung, Bad Godesberg (West Germany)). July 1966. 28p. (In German). Dep. mn.

Excitation functions and angular distributions of both γ transitions of the reaction ^{7}Li(p,γ)^{8}Be were measured separately for proton energies between 0.8 and 3.1 MeV. To specify the spin and parity of the 19.06-MeV level in ^{8}Be, the energy dependence of the coefficients of the angular distributions and the excitation functions were calculated by superposition of three ^{8}Be levels over the nonresonant cross section due to the E1 giant resonance. The assignment of $J^\pi = 3^-$ was confirmed. (auth)

9932 (CEA-R-2985) INTERACTIONS A DEUX CORPS DANS LA REACTION ^{9}Be(n,nn)$\alpha\alpha$ A 14 MeV. I. MISE EN EVIDENCE DES ETATS RESONNANTS. (Two-Body Interaction in the Reaction ^{9}Be(n,nn)$\alpha\alpha$ at 14 MeV. I. Existence of Resonating States). Perrin, Claude (Commissariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires). Sept. 1966. 40p. (In French). Dep. mn.

Thesis. Submitted to Grenoble Univ., France. Faculte des Sciences.

The basic mechanisms of the reaction ^{9}Be(n,nn)$\alpha\alpha$ were studied together with their application to an experiment in which the two impulse vectors of the neutrons are measured. Kinematic and phase-space calculations were performed. An analysis of groups of events (n,2n) observed in the (T_1,T_2) plot shows a sequence of two-body interactions: inelastic scattering by ^{9}Be(n,n′) followed by emission of neutrons ^{9}Be* → ^{8}Be* + n of the decay of the (6.76-7.94-9.1 MeV) levels of ^{9}Be to ^{8}Be in the (0+) and (2+) states. (auth)

9933 NEUTRON EMISSION FOLLOWING MUON CAPTURE IN ^{16}O. Raphael, R.; Ueberall, H.; Werntz, C. (Catholic Univ. of America, Washington, D. C.). Phys. Lett., 24B: 15-18(Jan. 9, 1967).

Using a generalized Goldhaber-Teller model for the nuclear giant dipole resonances, and its extension to giant multipole resonances, the muon capture rates in ^{16}O leading to 0$^+$ and 1$^+$ monopole; 0$^-$, 1$^-$, and 2$^-$ dipole; and 1$^+$, 2$^+$, and 3$^+$ quadrupole states in ^{16}N were evaluated. The subsequent neutron emission was considered on the basis of Wigner's R matrix theory. The neutron spectrum is dominated by the dipole resonances, especially by the 2$^-$ state. (auth)

9934 ^{16}O DIPOLE RESONANCE STATES. Fujii, S. (Nihon Univ., Tokyo). Phys. Lett., 24B: 7-9(Jan. 9, 1967).

A one-step calculation for ^{16}O(γ,n)^{15}O is attempted considering a coupling between different channels in final states. The method used allows a unified description of both discrete and continuous levels. (auth)

9935 T-FORBIDDEN ELECTRIC DIPOLE TRANSITION IN ^{16}O. Yoccoz, J.; Jang, S. (Centre de Recherches Nucleaires, Strasbourg. Institut de Recherches Nucleaires, Strasbourg, France). Phys. Lett., 24B: 9-10(Jan. 9, 1967).

The isobaric spin impurities of the four lowest odd-parity dipole states with T = 0 or T = 1 in ^{16}O are investigated using the particle-hole wave function. The widths for the ground-state T-forbidden gamma radiation are estimated. (auth)

9936 TRANSITION RATE OF ANALOG LEVELS IN A = 10 NUCLEI. Paul, P.; Fisher, T. R.; Hanna, S. S. (Stanford Univ., Calif.). Phys. Lett., 24B: 51-3(Jan. 9, 1967).

A recent determination of the transition rate between the first two T = 1 levels in ^{10}B disagrees with the analog rates in ^{10}Be and ^{10}C. A remeasurement gives an upper limit consistent with isospin conservation. A measurement is also made of the 5.16 → 3.59 MeV transition in ^{10}B. (auth)

9937 ON THE SHELL-MODEL INTERPRETATION OF THE INELASTIC SCATTERING OF 185-MeV PROTONS FROM ^{7}Li. Johansson, A. (Gustaf Werner Inst., Uppsala). Phys. Lett., 24B: 29-32(Jan. 9, 1967).

The cross sections and polarizations for the inelastic scattering of 185-MeV protons from the first and second excited states in ^{7}Li are calculated in the plane-wave impulse approximation using shell-model wave functions in configurations $(1s)^4(1p)^3$, $(1s)^4(1p)^2(2p)$, $(1s)^4(1p)^2(1f)$ and $(1s)^3(1d)(1p)^3$. The results are compared with experiment. (auth)

9938 ^{13}C(^{3}He,α)^{12}C REACTION AND ELASTIC SCATTERING OF ^{3}He FROM ^{13}C AT 12, 15, AND 18 MeV. Kellogg, E. M.; Zurmuehle, R. W. (Univ. of Pennsylvania, Philadelphia). Phys. Rev., 152: 890-9(Dec. 16, 1966).

The reaction ^{13}C(^{3}He,α)^{12}C was studied at 12, 15, and 18 MeV. Complete angular distributions of elastically scattered ^{3}He as well as those of α particles leading to the ground, 4.433-, 7.656-, 9.64-, 10.84-, 11.83-, and 12.71-MeV states were measured. A set of optical-model parameters that fits the elastic-scattering cross section of ^{3}He at all three energies was found with the Hunter program. It shows only a slight negative energy dependence of the real well depth and a positive energy dependence of the imaginary well depth. Distorted-wave Born approximation (Julie) analysis shows pickup of l = 1 or 0 for all except the 9.64-MeV state, where l = 2 is found. Relative spectroscopic factors were extracted. (auth)

9939 STUDY OF ^{14}N BY THE REACTION ^{13}C(^{3}He,d)^{14}N. Holbrow, C. H.; Middleton, R.; Rosner, B. (Univ. of Pennsylvania, Philadelphia). Phys. Rev., 152: 970-4(Dec. 16, 1966).

A thin carbon foil enriched to 91% in ^{13}C was bombarded with 15-MeV ^{3}He ions from a tandem electrostatic accelerator. Angular distributions of deuterons corresponding to the bound states of ^{14}N were measured with a single-gap magnetic spectrograph. Distorted-wave calculations were performed and spectroscopic factors were extracted. Agreement with the predictions of intermediate-coupling theory is very good, indicating that this theory provides a good description of states arising from p-shell configurations. (auth)

9940 ^{19}F(^{3}He,^{3}He)^{19}F AND ^{19}F(^{3}He,α)^{18}F REACTIONS AND STATES IN ^{18}F AT 3.06 AND 3.13 MeV. Matous, G. M.; Herling, G. H.; Wolicki, E. A. (Naval Research Lab., Washington, D. C.). Phys. Rev., 152: 908-13(Dec. 16, 1966).

Differential cross sections were obtained for the elastic scattering of ^{3}He from ^{19}F at 4.0, 6.0, and 8.0 MeV. The results obtained at 6.0 and 8.0 MeV were fitted using optical potentials. Measurements on the ^{19}F(^{3}He,α)^{18}F reaction were made on resolved alpha-particle groups leading to states in ^{18}F at 3.06 and 3.13 MeV. Excitation functions were obtained in the incident energy range

from 4.0 to 10.1 MeV at laboratory angles of 20, 50, 130, and 170°. Differential cross sections as a function of angle were obtained at 4.0, 6.0, and 8.0 MeV. Zero-range distorted-wave Born approximation calculations were made assuming pickup as the dominant mechanism. The 3.13-MeV level in ^{18}F was assigned a negative parity, that at 3.06 MeV was assigned a positive parity. The ratio of spectroscopic factors obtained for these two levels is approximately equal to 1. (auth)

9941 EXCITATION ENERGY AND LIFETIME OF THE ^{15}O 7276-keV STATE. Alburger, D. E.; Warburton, E. K. (Brookhaven National Lab., Upton, N. Y.). Phys. Rev., 152: 914-17 (Dec. 16, 1966). (BNL-10375).

An accurate determination of the energy of the sixth excited state in ^{15}O was carried out because of the proximity of this level to the proton binding energy and the resulting possibility of its importance in the stellar formation of ^{15}O. Gamma rays from this state occurring in the $^{14}N(d,n)^{15}O$ reaction at $E_d = 3.2$ MeV were measured by means of a Ge(Li) detector at 90° to the beam. The transition leading to the 5241.3 ± 0.5-keV level of ^{15}O is found to have an energy of 2034.7 ± 0.3 keV. Thus the ^{15}O level in question has an energy of 7276.0 ± 0.6 keV, which is 16.8 ± 1.3 keV below the proton binding energy of 7292.8 ± 1.2 keV. From a measurement at 0° to the beam, the 0 to 90° Doppler shift of the 2035-keV gamma ray is found to be 2.3 ± 0.4 keV. For a very short lifetime, the expected Doppler shift is 14.4 ± 1.3 keV. The observed shift corresponds to a mean lifetime of $1.25 \pm 0.3 \times 10^{-12}$ sec for the 7176-keV state of ^{15}O. (auth)

9942 EFFECTIVE INTERACTIONS IN ^{14}C. Gupta, Raj K. (Univ. of Toronto); Sood, P. C. Phys. Rev., 152: 917-23(Dec. 16, 1966).

Conventional shell-model calculations on the assumption of jj coupling were made for the level spectrum ^{14}C considering ^{12}C as the core. The three different choices of the exchange mixture considered are s-state interaction only, singlet-even interaction only, and singlet-even and triplet-odd interaction. The configuration-mixing effects are also studied and are found to be insignificant. The energy levels are satisfactorily explained with an attractive but weak singlet-even (Serber-type) interaction operating only in s and d states, and of a fairly long Gaussian range. The importance of the d-state forces is pointed out, and the configuration assignments to various levels are made. (auth)

9943 ANGULAR DISTRIBUTIONS AND TOTAL CROSS SECTIONS OF CHARGED PARTICLES FROM $^6Li + ^6Li$ AS A FUNCTION OF ENERGY. Kibler, K. G. (Univ. of Iowa, Iowa City). Phys. Rev., 152: 932-49(Dec. 16, 1966).

The $^6Li + ^6Li$ reaction was studied at 13 incident energies between 2.4 and 9.0 MeV, using a dE/dx-E particle identification system and an on-line computer. Total cross sections and angular distributions were obtained for protons from the first 12 levels of ^{11}B, deuterons from the first 5 T = 0 levels in ^{10}B, and tritons from the ^9B ground state. Noticeable variations in the proton angular distributions as a function of bombarding energy and indications of a (2J + 1) dependence of the proton cross sections as the bombarding energy was increased are indicative of compound nucleus effects. On the other hand, in the deuteron results, the dominant reaction mechanism is the transfer of an alpha particle. This process is favored for the residual states which are formed by $l_\alpha = 0$ transfer. There is no evidence for strong structure in the yield curves for the deuteron groups from one energy to the next. Simple considerations of the transfer as a tunneling process, possibly modified by the presence of a long-range effective interaction, adequately describe the deuteron cross sections. Measurements were made on the ground-state deuteron group at a bombarding energy corresponding to measurements on the inverse reaction, $^{10}B(d,^6Li)^6Li$, and the angular distribution and total cross section are in good agreement. The differential cross-section ratio of the 16.62- to 16.92-MeV levels in the $^6Li(^6Li,\alpha)^8Be$ reaction was also measured and found to be 1.20±0.10 and constant as a function of ^6Li energy. (auth)

9944 STUDY OF MASS 5 AND 7 NUCLEI BY (p,t) AND (p,^{3}He) REACTIONS ON ^7Li AND ^9Be. Cerny, J.; Detraz, C.; Pehl, R. H. (Univ. of California, Berkeley). Phys. Rev., 152: 950-5(Dec. 16, 1966). (UCRL-16956).

Triton and ^3He energy spectra and angular distributions from 43.7-MeV-proton bombardment of ^9Be and ^7Li were obtained. The restrictions on direct (p,t) reactions as compared to (p,^{3}He) reactions may result in the absence of certain transitions for the former because these transitions are "S forbidden"; several examples of this selection rule were observed. Though the lowest $T = 3/2$ states of the mass-7 product nuclei were readily observed, a search for $T = 3/2$ states in mass 5 was unsuccessful. (auth)

9945 STUDY OF ^{16}N BY $^{15}N + n$ TOTAL-CROSS-SECTION MEASUREMENT. Fossan, D. B.; Chalmers, R. A.; Salisbury, S. R.; Vaughn, F. J. (Lockheed Palo Alto Research Labs., Palo Alto, Calif.). Phys. Rev., 152: 980-4(Dec. 16, 1966).

The total neutron cross section ^{15}N was measured for neutron energies from 3.4 to 6.5 MeV corresponding to ^{16}N excitation energies from 5.5 to 8.5 MeV. Neutrons with energy spreads between 15 and 50 keV were produced by the D(d,n)^{3}He reaction with deuterons from a Van de Graaff accelerator. Resonance structure was observed in the cross section which corresponds to levels in ^{16}N; the resonance amplitudes were interpreted in terms of J values for these levels. The experimental results were compared with theoretical calculations of Lemmer and Shakin, and the excitation energies of the observed resonances were compared with those of known T = 1 levels for the $^{16}N-^{16}O-^{16}F$ isobaric triad. (auth)

9946 INTRINSIC STATES OF DEFORMED NUCLEI IN THE HARTREE–FOCK (HF) APPROXIMATION. Muthukrishnan, R. (Univ. of Michigan, Ann Arbor). Nucl. Phys., A93: 417-35(1967).

An application of the HF method to deformed nuclei is outlined. The two-nucleon interaction used is a nonlocal separable potential which acts only in relative s-states. The HF equations are solved in the matrix formulation. Calculations are performed for ^{16}O, ^{20}Ne, ^{24}Mg, ^{28}Si, ^{32}S, ^{36}Ar, and ^{40}Ca. The 4p-4h state of ^{16}O is also investigated. Solutions corresponding to different kinds of deformation are investigated. Single-particle energies and wave functions are obtained. The intrinsic quadrupole moments are also calculated. (auth)

9947 MEASUREMENT OF THE DIFFERENTIAL CROSS SECTION AT 180 DEG. Ogino, Kouya; Maeda, Kazuhiko (Kyoto Univ.). Genshikaku Kenkyu, 11: 279-96(Oct. 1966). (In Japanese).

With a reaction-particle analyzer at 0°, the differential cross section was measured at 180° by the recoil-particle method. The scattering of alpha particles by ^9Be at $E_\alpha = 28.5$ MeV was observed. The recoil-particle ^9Be was obtained at 0°. The differential cross section at 180° was estimated and was found to be considerably larger. (NSA of Japan)

9948 ELASTIC SCATTERING OF 7- TO 14-MeV NEUTRONS FROM NITROGEN. Bauer, R. W.; Anderson, J. D.; Lutz, H. F.; Wong, C.; McClure, J. W.; Pohl, B. A. (Univ. of California, Livermore). Nucl. Phys., A93: 673-82(1967). (UCRL-70057).

The differential cross sections for the scattering of neutrons with incident energies of 6.78, 7.41, 7.93, 8.35, 8.57, 9.38, 10.10, 10.93, 11.55, 12.25, 13.50, and 13.96 MeV from nitrogen were measured for lab angles between 15 and 135° in 15° steps. The measurements were made with a liquid target in cylindrical geometry with a thickness of approximately one half of the total mean free path. The neutrons were produced by the D(d,n)^{3}He reaction in the Livermore variable-energy cyclotron; the average neutron energy spread was ±200 keV. A multiple detector time-of-flight system was used for simultaneous recording of the data. The experimental differential cross sections are analyzed in terms of the optical model, with only the real and imaginary potentials varied. (auth)

9949 ELECTROEXCITATION OF GIANT-RESONANCE, SURFACE-PHONON STATES IN ^{12}C. Ueberall, H. (Catholic Univ. of America, Washington, D. C.). Phys. Rev. Lett., 17: 1292-4(Dec. 26, 1966).

The generalized Goldhaber-Teller model is used for a calculation of electroexcitation of giant resonance states with a superimposed surface-vibration phonon. A behavior similar to that of the giant resonances is found as a function of momentum transfer. (auth)

9950 SCATTERING OF FAST ELECTRONS ON THE ^6Li NUCLEUS AND THE CLUSTER MODEL. Kudeyarov, Yu. A.; Smirnov, Yu. F.; Chebotarev, M. A. (Moscow State Univ.). Yadern. Fiz., 4: 1048-51(Nov. 1966). (In Russian).

The form factors for the elastic and inelastic (with the excitation of the 2.18-MeV level) scattering of fast electrons on the ^6Li nucleus are calculated in the cluster model. A comparison of the calculated form factors with the experimental data shows that a good agreement with the experiments is obtained for the isolation parameters of a- and d-clusters equal to x = 0.3 to 0.4. The obtained value of the isolation parameter x indicates that a- and d-clusters are significantly separated in the ^6Li nucleus. (auth)

9951 DISINTEGRATION OF LIGHT NUCLEI IN COULOMB FIELDS. Wittern, Hans W. (Univ., Tuebingen, Ger.). Fortschr. Phys., 14: 401-27(1966). (In German).

The theory of disintegration of light atomic nuclei induced by the Coulomb field is treated in the framework of the general theory of nuclear reactions. Of special significance for applications is the semiclassical treatment, whose limits of validity are discussed. The results obtained by this method are discussed. (tr-auth)

9952 DISINTEGRATION OF ^{14}N BY FAST NEUTRONS. Csikai, J.; Nagy, S. (Inst. of Nuclear Research, Hungarian Academy of Sciences, Debrecen). Acta Phys. Acad. Sci. Hung., 21: 303-10(1966).

The energy spectrum and angular distribution of alpha particles from the reaction $^{14}N(n,\alpha)^{11}B$ measured at $E_n = 14,7$ MeV with a cloud chamber, are well described by the statistical model. A nuclear temperature of 2.0 ± 0.1 MeV was obtained. The cross sections for the reactions $^{14}N(n,p)^{14}C$ and $^{14}N(n,np)^{13}C$ are 77 ± 14 and 46 ± 13 mb, respectively. The measured cross-section ratio for the emission of protons and alpha particles and the ratio calculated with the statistical model are in good agreement. (auth)

9953 NUCLEAR LIFETIME EFFECTS ON GAMMA-RAY ANGULAR DISTRIBUTIONS FROM GAS TARGETS. McCallum, G. J.; Sowerby, B. D. (Australian National Univ., Canberra). Nucl. Instrum. Methods, 47: 45-54(1967).

It is shown that when gas targets are employed in the study of nuclear reactions initiated by accelerator-produced particles it is important to recognize the effects which nuclear lifetimes can produce on the observed gamma-ray angular distributions. These effects arise from the nonuniform emission of the gamma rays of interest along the axis of the target chamber. Expressions to estimate these effects are presented and compared with experiment. (auth)

Nuclear Properties and Reactions, 20 ≤ A ≤ 89

Refer also to abstracts 8368, 8416, 9929, 9946, 10010, 10045, 10064, 10075, 10089, 10101, and 10119.

9954 (AD-633731) A STUDY OF THE $^{36}S(p,\gamma)^{37}Cl$ REACTION WITH BOMBARDING ENERGIES IN THE 790-keV TO 1820-keV RANGE. Perrizo, Jerry Joseph (Air Force Inst. of Tech., Wright-Patterson AFB, Ohio. School of Engineering). Feb. 1966. 65p. (GSP-Phys-66-16). CFSTI $3.00 cy, $0.65 mn.

Thesis.

A search for resonances in the $^{36}S(p,\gamma)^{37}Cl$ reaction was conducted using protons with energies in the 790- to 1820-keV range. Approximately 80 previously unreported resonances were found in the energy region studied. The observed widths appear to be due to target thickness and instrumental effects. The intrinsic strengths, obtained by normalizing the relative strength of each ^{36}S resonance to that of the 1214-keV resonance in the $^{34}S(p,\gamma)^{35}Cl$ reaction, ranged from 0.02 to 1.16 eV. Preliminary analysis of data obtained from gamma spectra has shown evidence for possible previously unreported low-lying levels in ^{37}Cl at 4.3 and 5.4 MeV. (auth)

9955 (AD-642000) MASSES AND EXCITATION ENERGIES OF SOME PROTON-RICH NUCLEI. Miller, Richard G.; Kavanagh, R. W. (California Inst. of Tech., Pasadena). Oct. 1966. Contract Nonr-220(47). 55p. CFSTI $3.00 cy, $0.65 mn.

The Q values for seven (^3He,n) reactions were measured, using a silicon semiconductor detector as a fast-neutron spectrometer, with the following results (final nuclei, Q values in keV): ^{26}Si, 85 ± 18; ^{30}S, −573 ± 15; ^{34}Ar, −759 ± 15; ^{42}Ti, −2865 ± 6; ^{48}Cr, 5550 ± 18; ^{56}Ni, 4513 ± 14; and ^{60}Zn, 818 ± 18. The following excited states (excitation energies in MeV) were also seen: ^{26}Si, 1.79, 2.80; ^{30}S, 2.19; ^{34}Ar, 2.06; ^{48}Cr, 0.72 ?, 2.37 ?; ^{56}Ni, 2.69, 3.95, 6.60; and ^{60}Zn, 1.02. Rough measurements of the 0° (^3He,n) cross sections are given. Neutron angular distributions for $^{28}Si(^3He,n)$ to the ground and first excited states of ^{30}S are consistent with assignments of 0^+ and 2^+. Two gamma rays observed, with energies of 1.28 ± 0.06 and 2.66 ± 0.1 MeV, are attributed to $^{54}Fe(^3He,n\gamma)^{56}Ni$. The ($^3He$,p) Q values of nuclear reactions forming ^{48}V, ^{56}Co, and ^{60}Cu were measured with a magnetic spectrometer. The ground-state Q values for ^{56}Co and ^{60}Cu are 7410 ± 10 and 5770 ± 12 keV. Many excited states were seen: ^{48}V (3), ^{56}Co (15), and ^{60}Cu (23). (auth)

9956 (DESY-66/23) INTERACTIONS OF 1.5 GeV/c K^--MESONS WITH EMULSION NUCLEI: GENERAL CHARACTERISTICS, PRODUCTION, AND DECAY OF HYPERFRAGMENTS. Cuevas, J.; Diaz, J.; Harmsen, D. M.; Just, W.; Lohrmann, E.; Schink, L.; Spitzer, H.; Teucher, M. W. (Deutsches Elektronen-Synchrotron, Hamburg (West Germany)). Sept. 1966. 56p. Dep. mn.

Data are given on 141 stars found by a scan along the track of 1.5 GeV/c K^--mesons in nuclear emulsion. The mean free path is 47 ± 4 cm. In an area scan 1270 hyperfragments were observed, corresponding to a directly observed production rate of (3.1 ± 0.1) per cent. The corrected production rate is 7.6 per cent. The production rate in light (CNO) nuclei is (1-2) per cent, and in heavy (Br, Ag) nuclei it is 9 per cent. Details on 88 mesic hyperfragments are given, of which 43 could be uniquely identified. Three heavy mesic hyperfragments give for the binding energy $B_\Lambda < 27$ MeV. One π^+ decay of a Li-hyperfragment was observed. The nonmesic decay of heavy (spallation-) hyperfragments proceeds mostly by neutron stimulation. The stimulation ratio is $\gamma = P_n/(P_n + P_p) \approx 0.9$. Production of fission hyperfragments was studied using two independent criteria for fission events. The best estimate is 2−4 per cent for the fraction of fission hyperfragments among all observed Br or Ag hyperfragments. (auth)

9957 (UCRL-14984) BETA-GAMMA (CIRCULARLY POLARIZED) CORRELATION AND GAMMA SPECTROSCOPIC STUDIES ON ^{27}Mg. Bigoni, Robert A. (California Univ., Livermore. Lawrence Radiation Lab.). July 18, 1966. Contract W-7405-eng-48. 35p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Thesis.

Studies were made of the circular polarization of the two high-energy γ rays (1.01 MeV and 0.84 MeV) following the two-branch β^- decay of ^{27}Mg to ^{27}Al. The photon's (i.e., γ-ray's), spin polarization is a result of its being detected in coincidence with an immediately preceding β particle which possesses, in the relativistic limit, 100% longitudinal polarization (transferred in part to the γ ray) by virtue of the complete breakdown of parity in β decay. The γ-ray polarization measurements were done with γ polarimeters based on the principle of the dependence of the Compton-scattering cross section on the relative orientation of electron spin and photon spin. The γ polarimeters were geometrical configurations of magnetized iron which provided collections of partially aligned electrons from which the γ rays could Compton-scatter. A computer calculation of the detection efficiency of one of these configurations (two were utilized in the present work) was necessary in order to separate the effects due to the two γ rays of principal interest in this investigation. The polarimeter results for the two γ rays of concern are given, as usual, in terms of an asymmetry parameter, A, which gives the photon polarization when the angle between the photon and its coincident β-particle is 0°. In addition, a spectroscopic study of all three γ rays (1.01-, 0.84-, and 0.175-MeV) involved in this decay was made using a lithium-drifted germanium detector in conjunction with standard techniques of multichannel pulse-height analysis. (auth)

9958 GAMMA DECAY OF PROTON RESONANCES IN ^{54}Mn AND ^{55}Mn. Jonsson, L.; Skeppstedt, Oe.; Arnell, S. E. (Chalmers Univ. of Tech., Goteborg). Ark. Fys., 32: 549-62(1966).

The gamma de-excitation of a few resonances in the $^{53}Cr(p,\gamma)^{54}Mn$ and $^{54}Cr(p,\gamma)^{55}Mn$ reactions was investigated. Information about gamma branching of low lying levels in these nuclei was obtained. Some new excited levels are also reported. (auth)

9959 GAMMA TRANSITIONS IN ^{57}Co. Persson, P. O.; Arnell, S. E. (Chalmers Univ. of Technology, Goteborg). Ark. Fys., 33: 371-5(1966).

The proton resonances at 1248 and 1349 keV in the reaction $^{56}Fe(p,\gamma)^{57}Co$ were studied using a Ge(Li) spectrometer. A decay scheme is proposed for the 1248-keV resonance. More accurate level energies are reported. (auth)

9960 ANGULAR DISTRIBUTIONS OF NEUTRONS ELASTICALLY SCATTERED BY NATURAL COPPER IN THE ENERGY REGION 1.5 TO 4.6 MeV. Antolkovic, B.; Holmqvist, B.; Wiedling, T. (Aktiebolaget Atomenergi, Studsvik, Sweden). Ark. Fys., 33: 297-312(1966).

Angular distributions of neutrons elastically scattered by Cu were measured at seven energies from 1.46 to 4.56 MeV using the time-of-flight technique. The data were collected at several angles between 20 and 160°. The differential elastic scattering cross sections for Cu were determined relative to the well-known neutron cross sections for C and H by performing comparative measurements of the neutron elastic scattering from these elements. The experimental angular distributions were corrected for anisotropy of the neutron source, attenuation of the neutron flux in the scatterer, multiple neutron elastic scattering, and for the finite source-sample geometry using a Monte Carlo computer program. The corrected angular distributions are obtained in the form of Legendre polynomial expansions expressing the differential cross sections in the cms system. Theoretical angular distributions were fitted to the experimental distributions using the optical model. (auth)

9961 PRECISION GAMMA-RAY ENERGY MEASUREMENTS. Ramayya, A. V. (Vanderbilt Univ., Nashville); Hamilton, J. H.; Brahmavar, S. M.; Pinajian, J. J. Phys. Lett., 24B: 49-51 (Jan. 9, 1967).

The energies of several transitions which are useful as calibra-

tion standards over the energy range from 800 to 1850 keV were measured with an accuracy of 0.10 keV. (auth)

9962 THE $^{51}V(t,p)^{53}V$ REACTION. Hinds, S.; Marchant, H.; Middleton, R. (Atomic Weapons Research Establishment, Aldermaston, Eng.). Phys. Lett., 24B: 34-7(Jan. 9, 1967).

Proton angular distributions and energy levels of ^{53}V were measured at E_t = 12.09 MeV. The spin and parity of the ground state of ^{53}V was determined to be $^7/_2^-$, and its mass excess was measured to be −51.863 ± 0.025 MeV. (auth)

9963 ANALOGOUS $3/2^-$ LEVELS IN ^{43}Ca AND ^{41}Ar. Fossan, D. B. (State Univ. of New York, Stony Brook. Brookhaven National Lab., Upton, N. Y.); Poletti, A. R. Phys. Lett., 24B: 38-40(Jan. 9, 1967).

Lifetime measurements of the $^3/_2^-$ levels in ^{43}Ca at 594 keV and ^{41}Ar at 518 keV yield M1 hindrances within the predominantly $f_{7/2}^3$ configurations of (≤300) and 3000, respectively. These results are compared with M1 matrix elements between the $f_{7/2}^2 p_{3/2}$ admixtures obtained from recent theoretical calculations. (auth)

9964 CROSS SECTION OF THE REACTION $^{28}Si(\gamma,n)$. Goryachev, B. I.; Ishkanov, B. S.; Shevchenko, V. G.; Yurev, B. A. (Moscow State Univ.). JETP Lett. (USSR) (Engl. Transl.), 4: 330-1(Dec. 1, 1966).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Redaktsiyu, 4: 491-3(Dec. 1, 1966).

The cross section of the photoneutron yield curve from the reaction $^{28}Si(\gamma,n)$ is found to have five clearly pronounced maxima. A configuration splitting of the giant dipole resonance is clearly observed for the last two maxima which apparently correspond to high-energy transitions. (J.F.P.)

9965 OBSERVATION OF THE MOESSBAUER EFFECT IN ^{165}Ho. Rousskov, T.; Tomov, T.; Popov, H. (Inst. of Physics, Academy of Sciences, Bulgaria). Compt. Rend. Acad. Bulg. Sci., 19: 701-4(1966).

The first excited level of ^{165}Ho was obtained in β decay of ^{165}Dy ($T_{1/2}$ = 2.36 hours). The amplitude γ spectrum of ^{165}Ho, as well as the energy range on which the measurements are made, are shown. The Moessbauer spectrum of the 95-keV γ line in $^{165}Ho_2O_3$ is shown. The experimental width of the resonance line is $\Gamma = (2 \pm 0.2) \cdot 10^{-5}$ eV from where the lower limit of the half-life of that level can be obtained: $T_{1/2} \geq (2.2 \pm 0.2) \cdot 10^{-11}$ sec, which is agreement with the half-life measured by the method of Coulomb excitation. (M.H.R.)

9966 MASS ESTIMATES OF NONMESONICALLY DECAYING, SHORT-RANGE HYPERFRAGMENTS. Bhowmik, B.; Chand, T.; Chopra, D. V. (Univ. of Delhi). Nucl. Phys., 87: 618-24(1966).

Minimum masses of seven short-range nonmesonic hyperfragments selected on the basis of high visible energy and large momentum unbalance at the decay star were estimated from decay-star analysis. The hyperfragments are found to have masses ≳25 and provide direct evidence for the existence of heavy hyperfragments. The probable masses were also estimated from the production-star analysis assuming the validity of the spallation model for the production of such hyperfragments. The masses are found to lie in the mass range $35 \lesssim A \lesssim 85$. The masses found by the two methods are not inconsistent. (auth)

9967 TRANSITION PROBABILITIES WITHIN THE $(f_{7/2})^3$ CONFIGURATION OF ^{41}Ar. Fossan, D. B. (State Univ. of New York, Stony Brook. Brookhaven National Lab., Upton, N. Y.); Poletti, A. R. Phys. Rev., 152: 984-9(Dec. 16, 1966). (BNL-10418).

The lifetimes of the 165- and 518-keV levels of ^{41}Ar were measured by fast timing techniques. Half lives of 410 ± 30 and 340 ± 20 psec, respectively, were obtained from logarithmic slopes of the time-delay distributions. The time delays were marked by protons from the $^{40}Ar(d,p\gamma)^{41}Ar$ reaction detected in a solid-state counter and gamma rays detected with a plastic scintillator. The lower error limit for the half life of the 165-keV level is somewhat uncertain because of difficulties in obtaining a true prompt resolution function for this measurement. M1 hindrances relative to Moszkowski estimates for the 165- and 353-keV gamma rays are approximately 100 and 3000, respectively. These hindrances are consistent with dominant $(f_{7/2})^3$ configurations predicted for the first three levels of ^{41}Ar by Shadmi and Talmi plus a 2% $(f_{7/2})^2$ ($f_{5/2}$) admixture into the 165-keV state. The 518-keV E2 transition to the ground state, which is enhanced by a factor of approximately 5 relative to single-particle estimates, requires an effective neutron charge of 2.3e for $(f_{7/2})^3$ configurations. (auth)

9968 STUDY OF THE REACTION $^{27}Al(d,\alpha)^{25}Mg$ AT 20.9 MeV. Priest, Joseph R.; Vincent, John S. (Lewis Research Center, Cleveland). Phys. Rev., 152: 989-94(Dec. 16, 1966).

The differential cross sections corresponding to the excitation of seven states of the residual nucleus in the reaction $^{27}Al(d,\alpha)^{25}Mg$ were measured from 20 to 170° for a deuteron energy of 20.9 MeV (lab). The states resolved correspond to the first three members (ground, third, and eighth states) of the $K = 5/2$ rotational band, the first three members (first, second, and fourth states) of the $K = 1/2$ rotational band, and a state at 5.47 ± 0.03 MeV. The angular distributions are all peaked in the forward direction with very little enhancement of the differential cross sections at large angles. The integrated differential cross sections for the first three $K = 5/2$ states are 459, 475, and 417 μb, respectively, as compared to 38, 38, and 95 μb for the first three $K = 1/2$ states. The angular distributions corresponding to a given rotational band in ^{25}Mg are strikingly similar both in magnitude and shape. Analysis of the energy-level structure in terms of the rotational model indicates that the state in ^{25}Mg at 5.47 ± 0.03 MeV is the $1^1/_2$ member of the $K = 5/2$ rotational band. (auth)

9969 BETA-DELAYED PROTONS FROM ^{33}Ar, ^{37}Ca, AND ^{41}Ti. Poskanzer, A. M.; McPherson, R.; Esterlund, R. A.; Reeder, P. L. (Brookhaven National Lab., Upton, N. Y.). Phys. Rev., 152: 995-1001(Dec. 16, 1966). (BNL-10362).

Delayed-proton emission following the beta decay of ^{33}Ar, ^{37}Ca, and ^{41}Ti was investigated in more detail. The number of proton peaks was observed to be six, ten, and seventeen, respectively. The half lives were determined to be 178 ± 5, 177 ± 5, and 88 ± 1 msec, respectively. Decay schemes are presented by assigning the peaks to virtual levels in ^{33}Cl, ^{37}K, and ^{41}Sc. The excitation energies of the first $T = 3/2$ levels were measured to be 5.556 ± 0.020, 5.021 ± 0.020, and 5.90 ± 0.03 MeV, respectively. (auth)

9970 LIFETIMES OF THE FIRST AND SECOND EXCITED STATES OF ^{21}F. Mendelson, R. A. Jr.; Carpenter, R. T. (Univ. of Iowa, Iowa City). Phys. Rev., 152: 1002-5(Dec. 16, 1966).

Lifetimes of the 0.279-MeV and 1.10-MeV states produced in the reaction $^{18}O(^7Li,\alpha)^{21}F$ were measured using the delayed-coincidence technique. A solid-state detector was used to measure the energies of the alpha particles as well as to produce timing signals. The half life of the 0.279-MeV state was determined to be $7.03 \pm 0.50 \times 10^{-9}$ sec and that of the 1.10-MeV state less than 2×10^{-10} sec. The lifetime of the 0.79-MeV level implies an E2 transition and a $^1/_2^+$ assignment for the spin. This result is in agreement with two-nucleon stripping fits. The level order can be understood on the basis of the rotational model with band mixing using a lower distortion for ^{21}F than for neighboring $T = 1/2$ nuclei. The measured lifetimes are in qualitative agreement with this model. (auth)

9971 EVIDENCE FOR HINDERED FIRST-FORBIDDEN UNIQUE BETA BRANCH IN ^{47}Ca DECAY. Freedman, M. S.; Porter, F. T.; Wagner, F. (Argonne National Lab., Ill.). Phys. Rev., 152: 1005-10(Dec. 16, 1966).

An upper limit of $9.8 \pm 1.5 \times 10^{-4}$ per decay for the intensity of the first-forbidden unique beta transition from the $^7/_2^-$ ground state in ^{47}Ca to the $^3/_2^+$, 767.2-keV hole state in ^{47}Sc, was determined, by Ge(Li) spectrometry, as the difference between feed-out and feed-in gamma intensities. Gammas observed are (keV, 10^4 × intensity per decay): (530.6 ± 0.5, 9.6 ± 0.9), feed-in; and (767.2 ± 0.5, 19.4 ± 1.4), feed-out. However, the sum of the upper intensity limits observable for feed-in gammas from seven known higher energy levels in ^{47}Sc is four times higher than the above difference, which can thus be stated only as a limit to the beta intensity. This limit corresponds to $\log f_1 t \geq 9.5 \pm 0.2$, a slow first-forbidden unique case similar to the analogous decay in ^{45}Ca, for which $\log f_1 t = 9.2$. From the intensities (limits) observed for gammas from all levels to those certainly populated in ^{47}Ca decay (767.2, 807.9 and 1297.0 keV), log ft lower limits are obtained, ranging from 6.6 to 9.2, for these higher states. (auth)

9972 BETA FEEDING OF THE $d_{3/2}$ HOLE STATE IN ^{47}Sc. Kostroun, Vaclav O.; Rao, P. Venugopala; Crasemann, Bernd (Univ. of Oregon, Eugene). Phys. Rev., 152: 1010-12(Dec. 16, 1966). (RLO-1921-9).

The intensity of gamma rays which lead to and de-excite the 767-keV $^3/_2^+$ state of ^{47}Sc was measured in the decay of ^{47}Ca, with Ge(Li) detectors, in order to determine the intensity of a beta branch to this level and hence, after the method of Cohen and Lawson, to find the probability of core excitation in ^{47}Ca. The intensity of the 530-keV gamma transition which feeds the $^3/_2^+$ state is found to be $1.3 \pm 0.3 \times 10^{-3}$ per ^{47}Ca decay, while the 767-keV gamma ray de-excites this state with an intensity of $2.0 \pm 0.3 \times 10^{-3}$ per ^{47}Ca decay. If the difference between these intensities is entirely due to beta transitions to the $^3/_2^+$ state, then this first-forbidden unique branch of the beta spectrum is characterized by $\log f_1 t = 9.6$, and the probability of the $(d_{3/2})^{-2}$ configuration in the ground state of ^{47}Ca is 4 ± 3% if positive nuclear deformation is assumed and 6 ± 4% for negative deformation. (auth)

9973 (p,d) AND (p,t) REACTIONS ON THE Zn ISOTOPES AT 17.5 MeV. McIntyre, L. C. (Princeton Univ., N. J.). Phys. Rev., 152: 1013-22(Dec. 16, 1966). (PUC-937-225).

Angular distributions of the differential cross section for the (p,d) and (p,t) reactions on the five stable Zn isotopes, ^{64}Zn, ^{66}Zn, ^{67}Zn, ^{68}Zn, and ^{70}Zn, were obtained using 17.5-MeV protons. Between 9 and 15 deuteron groups were investigated for each isotope. Pickup of neutrons from the $1f_{5/2}$, $2p_{3/2}$, $2p_{1/2}$, and $1g_{9/2}$ subshells indicates considerable configuration mixing in the ground-state wave functions of the target nuclei. Several cases of "J dependence" were observed. Distorted-wave Born approximation calculations were carried out and spectroscopic factors and occupation numbers are presented. (auth)

9974 ALPHA-PARTICLE MODELS FOR ^{20}Ne AND ^{24}Mg. Hauge, Paul S.; Duffey, George H. (South Dakota State Univ., Brookings). Phys. Rev., 152: 1023-7(Dec. 16, 1966).

Energy levels of ^{20}Ne and ^{24}Mg were correlated with predictions of alpha-particle models belonging to various point groups. For ^{20}Ne, best results were obtained with the particles vibrating about the center and vertices of a D_{2d} distorted tetrahedron. For ^{24}Mg, the D_{4h} bipyramidal structure is suitable. (auth)

9975 SOME PROPERTIES OF THE 2.98-MeV LEVEL OF ^{23}Na. Rasmussen, V. K.; Khan, N. A. (Franklin Inst., Swarthmore, Pa.). Phys. Rev., 152: 1027-33(Dec. 16, 1966).

Nuclear-resonance-fluorescence techniques were used to measure the mean life of the 2.98-MeV level of ^{23}Na. The source of γ rays was the decay of the 2.98-MeV level of ^{27}Al, as excited by inelastic scattering of 4.90-MeV protons. Using the branching ratio $\Gamma_0/\Gamma = 0.56 \pm 0.06$, for the ground-state transition $\Gamma_0 = (g_1/g_2)$ $(77 \pm 12) \times 10^{-3}$ eV and for the total width $\Gamma = (g_1/g_2)$ $(140 \pm 20) \times 10^{-3}$ eV, where g_1 and g_2 are the statistical weights for the ground and excited states. The mean life is then $\tau = (g_2/g_1)$ $(4.7 \pm 0.8) \times 10^{-15}$ sec. It is found that the angular distribution for the resonance scattering is $1 + (0.87 \pm 0.13)P_2(\cos\theta)$. For the spin sequence $\frac{3}{2}-\frac{3}{2}-\frac{3}{2}$, this limits the E2/M1 amplitude ratio to $0.37 < \delta < 1.43$. For the sequence $\frac{3}{2}-\frac{5}{2}-\frac{3}{2}$, the limits are $-1.50 < \delta < -1.14$, $-0.47 < \delta < -0.31$, and $1.01 < \delta < 1.82$. This is not in agreement with other recent results on this level, and a plausible explanation for the difference was not found. The smallest value obtained for δ^2 corresponds to a B(E2) of approximately twice the single-particle value, $B(E2)_{SP}$. (auth)

9976 STATISTICAL-THEORY ANALYSIS OF THE ^{24}Mg(n,p) ^{24}Na AND THE ^{27}Al(n,α)^{24}Na REACTIONS. Butler, J. P.; Santry, D. C. (Atomic Energy of Canada, Ltd., Chalk River, Ont.). Phys. Rev., 152: 1034-45(Dec. 16, 1966).

Previously reported measurements of the average cross sections for the ^{24}Mg(n,p)^{24}Na and ^{27}Al(n,α)^{24}Na reactions are compared with a detailed statistical-theory calculation in which information on the spin and parity of possible final states is included. The calculations employ nuclear transmission functions evaluated from an optical model of the nucleus. Good agreement is obtained between the calculated and measured average cross sections for neutron energies from the effective thresholds of the reactions to 10 MeV in the center-of-mass system. For a given value of the nuclear potential, the data yield a unique value for the effective radius of the nucleus with its associated particle, $(R_0 + 1.5d)$, where d is the surface-thickness parameter. In agreement with the formulation of Lang, a value of 3.6 for the level-density parameter a for ^{27}Al is obtained from a theoretical fit of ^{27}Al(n,α) cross-section results at the higher neutron energies. Fluctuations observed in the ^{24}Mg(n,p)^{24}Na cross section are attributed either to the interference of overlapping levels in the compound nucleus ^{25}Mg, or to statistical variations in the number of levels of spin type $\frac{9}{2}^-$ and $\frac{7}{2}^-$ in the compound nucleus. These are the principal levels that give rise to the product, ^{24}Na. (auth)

9977 NUCLEON TRANSFER IN ^{10}B(^{14}N,^{13}N)^{11}B, ^{10}B(^{14}N,^{11}C)^{13}C, AND ^{40}Ca(^{14}N,^{13}N)^{41}Ca REACTIONS. Couch, J. G. (Texas A and M Univ., College Station); McIntyre, J. A.; Hiebert, J. C. Phys. Rev., 152: 883-9(Dec. 16, 1966). (ORNL-P-2480).

Thin targets of ^{10}B and ^{40}Ca were bombarded with ^{14}N ions from the Oak Ridge tandem van de Graaff accelerator. Ranges, angular distributions $d\sigma(\theta)/d\Omega$, and total cross sections $\sigma(E)$ were obtained by measuring the activities of the positron emitters ^{13}N and ^{11}C formed in the neutron and proton transfer reactions. The ^{10}B(^{14}N,^{13}N)^{11}B reaction was shown to involve primarily ground states of ^{11}B at an incident energy of 16.3 MeV. The angular-distribution data for this reaction were found, in their dependence on angle, to be consistent with tunneling-theory calculations. [Although cross-section calculations with the tunneling theory were limited to the ^{14}N(^{14}N,^{13}N)^{15}N reaction, the angular dependence calculated for the differential cross section can be used for other reactions.] A reduced width for the transferred neutron could not be determined, however, because of the specialization of the calculations to the ^{14}N(^{14}N,^{13}N)^{15}N reaction. In the ^{10}B(^{14}N,^{11}C)^{13}C reaction, the protons transfer to both the ground state and first excited state of ^{13}C, but no transfers involving the first excited state of ^{11}C were observed. For the ^{40}Ca(^{14}N,^{13}N)^{41}Ca experiments, reactions were found at the higher energies measured (>27.5 MeV) which led to excited states as well as to the ground state of ^{41}Ca. Again, the angular distributions were found to be consistent with the tunneling process. Total-cross-section data were also obtained which can be used for a neutron reduced-width determination in ^{41}Ca when the theory has been extended to this reaction (with the reservation that there is no evidence available that only one state in ^{41}Ca is involved in the transfer-process energies below 27.5 MeV). (auth)

9978 ANGULAR CORRELATION STUDIES AND LEVEL SCHEMES OF ^{58}Fe. Ramamohan, R. V.; Venkata Reddy, K.; Venkatapathi Raju, B. B.; Jnanananda, Swami (Andhra Univ., Waltair, India). Indian J. Pure Appl. Phys., 4: 420-2(Nov. 1966).

Gamma-gamma angular-correlation measurements were made for the 855 to 810 keV cascade, and the spin of the levels and the multipolarities of the transition were assigned. The correlation coefficients obtained are: $a_2 = 0.35 \pm 0.08$ and $a_4 = 0.23 \pm 0.05$. The multipolarity in the 855-keV transition is 73% quadrupole. These results agree closely with those determined from angular-correlation measurements as well as those theoretically determined for the class of even-even nuclei of the region $40 \leq A \leq 154$. (auth)

9979 (p,n) AND (p,2n) CROSS SECTIONS OF NINE ELEMENTS BETWEEN 7.0 AND 15.0 MeV. Chodil, G.; Jopson, R. C.; Mark, Hans; Swift, C. D.; Thomas, R. G.; Yates, M. K. (Univ. of California, Livermore. Univ. of California, Berkeley). Nucl. Phys., A93: 648-72(1967). (UCRL-14629).

The excitation functions and absolute cross sections for (p,n) and (p,2n) reactions were measured for thin targets of the elements aluminum, titanium, vanadium, cobalt, zirconium, niobium, silver, tantalum, and gold. The energy of the incident proton beam was varied between 7.0 and 15.0 MeV. The emitted neutrons were detected by a large gadolinium-loaded, liquid scintillator detector, and the two competing processes were separated by a statistical analysis. Thick-target total neutron yield cross sections were also measured. Nuclear level-density parameters for these elements were determined from the results. (auth)

9980 β-γ(CP) CORRELATION MEASUREMENTS AND THE SPIN OF ^{52}V. Bloom, S. D.; Mann, L. G. (Univ. of California, Livermore). Contract W-7405-eng-48. Nucl. Phys., A93: 252-6 (1967). (UCRL-14995).

The β-γ(CP) correlation in the case of the ^{52}V β decay to the first excited level ^{52}Cr was measured in an attempt to settle the question of whether the spin of ^{52}V is 2 or 3. (The spin-sequence is: 2^+ or 3^+ (β^-, 2.47 MeV) 2^+ (γ, 1.434 MeV) 0^+). The asymmetry parameter is observed to be $A = -0.302 \pm 0.022$. For the assumption of 3^+ for the ground state of ^{52}V, the expected value of A is unique, $(-\frac{1}{3})$. For the assumption of 2^+, the value of A expected is not unique but depends on the size of the interference between the Fermi and Gamow-Teller matrix elements, which are both permitted in this case. However, the measured value of A corresponds to a value of the Fermi matrix element which, when translated into the Coulomb matrix element giving rise to the Fermi transition, is about an order of magnitude larger than systematic studies of this quantity in other nuclei would lead one to expect, being in fact larger than any known (experimentally deduced) value for a non-diagonal Coulomb matrix element. Accordingly, it is concluded that the spin of ^{52}V can not reasonably be assigned any value other than 3^+. (auth)

9981 A SEARCH FOR THE LEVEL AT 803 keV IN ^{51}Cr. Iyengar, K. V. K.; Lal, B.; Gupta, S. K.; Deshpande, M. D. (Tata Inst. of Fundamental Research, Bombay). Nucl. Phys., A93: 257-60(1967).

The 803-keV level found in ^{51}Cr through the ^{50}Cr(d,p)^{51}Cr reaction does not seem to be generated in the ^{51}V(p,n)^{51}Cr reaction to an intensity greater than 2% of the 747-keV level as determined by observing the direct gamma radiations with a lithium-drifted germanium detector with incident protons of energy in the range 2.310 to 3.100 MeV. (auth)

9982 THE SCATTERING OF 50-MeV PROTONS BY ^{64}Zn AND ^{114}Cd. Edwards, V. R. W. (London Univ.); Fannon, J. A.; Burge, E. J.; Smith, D. A.; Swales, F. J. Nucl. Phys., A93: 370-84(1967).

Differential cross sections for the scattering of 49.6-MeV protons from the ground and first excited levels of ^{64}Zn and ^{114}Cd were measured between 10 and 146°. The scattered protons were detected with an array of solid-state counters mounted in the focal plane of a 180°, $n = \frac{1}{2}$, magnetic analyzer. Techniques which greatly improve the reliability of such arrays and a new method of measuring the dead spaces between the detectors are described. (auth)

9983 γ-γ ANGULAR CORRELATIONS IN THE REACTION $^{51}V(n,\gamma)^{52}V$. Carlos, P.; Samama, R.; Audias, A. (CEN, Saclay, France). Nucl. Phys., A93: 631-47(1967). (In French).

Experimental results are reported concerning γ-γ angular correlation measurements on ^{52}V after thermal-neutron capture. The data were recorded with a multiparameter unit, using a magnetic tape recorder. Comparison between experimental a_2/a_0 values and theoretical calculations confirm the 3^+ spin assignment of the ^{52}V ground state and give some necessary conditions to fit the theoretical level spectrum. (auth)

9984 SPECIFIC ACTIVITIES AND HALF-LIVES OF COMMON RADIONUCLIDES. Goldstein, Gerald; Reynolds, S. A. (Oak Ridge National Lab., Tenn.). Contract W-7405-eng-26. Nucl. Data, Sect. A, 1: 435-52(July 1966). (ORNL-P-2274).

A compilation is presented of the half lives, decay constants, and specific activities of 354 well-known radionuclides with half lives greater than one day. (auth)

9985 NUCLEAR PHOTOACTIVATION OF SELENIUM. Cauchois, Yvette; Heno, Yvonne; Boivin, Michel (Faculte des Sciences, Paris). Compt. Rend., Ser. B, 263: 868-71(Oct. 10, 1966). (In French).

The photoactivation of natural selenium was studied using the methods previously used for In, Cd, and Ag. Eight nuclear levels were observed in ^{77}Se, three of which were previously unknown. The energies were 250, 440, 520, 825, 932, 1000, 1190, and 1600 keV within ±10 keV. The corresponding effective cross sections were calculated. The discussion gives particular attention to the recent γ-spectrometric measurements performed on ^{77}As and ^{77}Br by Ythier et al., using semiconductor Ge(Li) detectors. (tr-auth)

9986 A METHOD FOR INTERNAL PAIR FORMATION MEASUREMENTS OF TRANSITIONS FROM PROTON–GAMMA REACTIONS. Spring, E. (Univ. of Helsinki). Nucl. Instrum. Methods, 45: 349-50(1966).

Measurements were made of internal pair formation coefficients Γ for the 12.33- and 10.76-MeV transitions in ^{28}Si using the $^{27}Al(p,\gamma)^{28}Si$ reaction at proton energies of 773 keV and 992 keV, respectively. Coefficients of $\Gamma(12.33\ MeV) = (2.3 \pm 0.4) \times 10^{-3}$ and $\Gamma(10.76\ MeV) = (2.0 \pm 0.3) \times 10^{-3}$ were found. The main problem involved in the measurements was ensuring that they were not subjected to the influence of external pair formation. The apparatus is described which is designed to minimize this problem. (S.F.L.)

9987 ENERGY LEVELS OF ^{56}Fe. MacDonald, J. R.; Grace, M. A. (Oxford Univ.). Nucl. Phys., A92: 593-607(1967).

The gamma-ray spectra from the decay of ^{56}Co and ^{56}Mn and from the $^{56}Fe(p,p'\gamma)$ reaction were studied using a Ge(Li) counter. The decay modes of all states up to 4.4 MeV were established except that at 3.39 MeV. Among the new features of the level structure, doublets at 3.12 and 3.45 MeV were identified. The 2.94-MeV level excited in the $^{56}Fe(p,p'\gamma)$ reaction was shown by γ-γ angular correlation measurements to have spin 0. (auth)

9988 SPIN ISOLATION PARAMETERS FOR SOME MEDIUM-WEIGHT NUCLEI FROM NEUTRON REACTIONS. Bormann, M.; Dreyer, F.; Seebeck, U.; Voigts, W. (Univ., Hamburg). Z. Naturforsch., 21a: 988-94(July 1966). (In German).

According to the Fermi gas model, the dependence of the nuclear level density on the angular momentum of the nucleus is determined essentially by the spin cut parameter σ. This can be obtained from the angular distributions of the emitted particle and from the ratio of the isomeric effective cross section for compound nuclear reactions, which can be described by the statistical theory of nuclear reactions. For some nuclear reactions of fast neutrons, this type of measurement data was determined and the spin cut parameters σ were derived for the nuclei ^{37}Ar, ^{56}Co, ^{61}Ni, ^{75}Ge, and ^{73}Se. The results were compared with the corresponding data from other works for medium-weight nuclei and with the predictions of the Fermi gas model. (tr-auth)

9989 EMISSION OF ^{8}Li FRAGMENTS IN INTERACTIONS OF 5-GeV/c ANTIPROTONS. Indira, B.; Shantalakshmi, A.; Kamal, A. A. (Osmania Univ., Hyderabad, India). Proc. Phys. Soc. (London), 89: 1061-3(Dec. 1966).

An analysis of 81 hammer tracks from interactions of antiprotons of momentum 5 GeV/c with Ag and Br nuclei is presented. The results are compared with evaporation theory using the values V = 5.8 MeV and T = 11.2 MeV. (auth)

9990 PROPERTIES OF ^{36}Ar AND ^{38}Ar NUCLEAR LEVELS EXCITED IN THE CAPTURE OF PROTONS BY CHLORINE ISOTOPES. Karadzhev, K. V.; Manko, V. I.; Chukreev, F. E. Yadern. Fiz., 4: 909-19(Nov. 1966). (In Russian).

The nuclear reactions $^{35}Cl(p,\alpha)^{32}S$ and $^{37}Cl(p,\alpha)^{34}S$, as well as the elastic scattering of protons on chlorine, were investigated, using 1.3 to 3.0 MeV protons. A significant difference was found between the α-particle angular distributions in the two reactions. An investigation of the α-particle angular distributions and the elastic scattering cross sections made it possible to determine the spins, parities, and reduced widths of 40 levels in the ^{38}Ar nucleus and 25 levels in ^{36}Ar. It was found that $\vartheta_\alpha^2 \gg \vartheta_p^2$ for the overwhelming majority of levels, where ϑ^2 is the reduced emission width for an α-particle or a proton, expressed in Wigner units. The reduced α-particle widths for both ^{36}Ar and ^{38}Ar were found to have relatively narrow distributions: about 0.1 and 0.02, respectively. Possible deviations from the Porter–Thomas distribution are discussed. (auth)

9991 REACTIONS $^{30}Si(d,p)^{31}Si$ AND $^{30}Si(^3He,d)^{31}P$. Betigeri, M.; Bock, R.; Duhm, H. H.; Martin, S.; Stock, R. (Max-Planck-Institut fuer Kernphysik, Heidelberg). Z. Naturforsch., 21a: 980-7(July 1966). (In German).

The reactions $^{30}Si(d,p)^{31}Si$ and $^{30}Si(^3He,d)^{31}P$ were investigated at $E_d = 10$ MeV and $E_{^3He} = 15$ MeV using a broadband magnetic spectrograph. For ^{31}Si, the angular distribution was measured for 20 levels from 5 to 120° and the l values and spectroscopic factors were determined by a DWBA analysis. On the basis of the target composition, 23 levels in ^{29}Si were measured together with ^{31}Si, and their spectroscopic factors agree with earlier measurements. The $l = 2$ angular distributions are structured or flat according to whether the spin of the final state is $3/2^+$ or $5/2^+$, so that the spin of the levels in ^{31}Si can also be determined by comparison. In ^{31}P, the l value and relative spectroscopic factors were determined from 4 spectra at 4 selected angles. An interpretation of the level structure and the spectroscopic factors of ^{31}Si and ^{31}P according to the shell model calculation of Glaudemans et al. fails, since in the calculations the $d_{\frac{3}{2}}$ shell is considered filled. The experimental application of the Nilsson model leads to small deformations $|\eta| < 2$, unless the level guide in this can be exactly explained. (tr-auth)

9992 ANGULAR DISTRIBUTIONS AND NEUTRON SPECTRA IN (d,n) REACTIONS ON MEDIUM ATOMIC WEIGHT NUCLEI. Okorokov, V. V.; Serezhin, V. M.; Smotryaev, V. A.; Tolchenkov, D. L.; Trostin, I. S.; Cheblukov, Yu. N. (Inst. of Theoretical and Experimental Physics, Moscow). Yadern. Fiz., 4: 975-84(Nov. 1966). (In Russian).

The neutron spectra and angular distribution in (d,n) reactions on the $^{50,52,53,54}Cr$, $^{54,56,57}Fe$, ^{59}Co, $^{58,60,62,64}Ni$, $^{63,65}Cu$, $^{64,66,68}Zn$ isotopes were investigated. The ITEPh cyclotron served as the source of 11.7-MeV deuterons. The measurements were performed using a multichannel time-of-flight spectrometer. The target thickness varied from 3.8 to 4.6 mg/cm^2. (auth)

9993 ELASTIC SCATTERING OF ^3He AND α-PARTICLES OF 16 AND 19.5 MeV FROM SEVERAL NUCLEI BETWEEN ^{40}Ca AND ^{64}Zn. Bock, R.; David, P.; Duhm, H. H.; Hefele, H.; Lynen, U.; Stock, R. (Max-Planck-Institut fuer Kernphysik, Heidelberg). Nucl. Phys., A92: 539-48(1967).

Elastic scattering of 19.47-MeV ^3He particles by ^{48}Ti, ^{52}Cr, ^{55}Mn, ^{58}Ni, ^{64}Zn, and ^{138}Ba has been observed over an angular range from 20° to 170°. The smooth angular distributions obtained have been analyzed by DWBA calculations using three different six-parameter Woods-Saxon potentials. The α-elastic scattering has been measured at 15.98 MeV from ^{42}Ca, ^{48}Ti, and ^{52}Cr and at 19.47 MeV from ^{40}Ca, ^{42}Ca, ^{48}Ti, ^{50}Ti, ^{52}Cr, ^{53}Cr, ^{55}Mn, ^{58}Ni and ^{60}Ni. The angular distributions of the titanium and chromium isotopes approximately fitted by average four-parameter potentials searched for different families of parameters with V ≈ 60, 90, 140, and 180 MeV. (auth)

9994 REACTION $^{39}K(^3He,p)^{41}Ca$ AND TWO-PARTICLE, ONE-HOLE STATES. Seth, K. K. (Northwestern Univ., Evanston, Ill.); Couch, R. G.; Biggerstaff, J. A.; Miller, P. D. Phys. Rev. Lett., 17: 1294-7(Dec. 26, 1966).

Two-particle, one-hole states were investigated using the $^{39}K(He-3,p)^{41}Ca$ reaction at 14 MeV. A number of strong proton groups corresponding to states in ^{41}Ca above 5.0 MeV were observed. Some of the groups probably consist of doublets or triplets, but their yields are as much as ten times the yield of groups below 4 MeV. None of the states (7) above 6.84 MeV were previously known. In the reaction $^{39}K(He-3,d)^{40}Ca$, which was simultaneously studied, the negative-parity 1p-1h states dominate the deuteron spectra. The T = 0 and T = 1 negative-parity states which are analogs of the ground-state $(d_{\frac{3}{2}}^{-1}f_{\frac{7}{2}})$ quartet of ^{40}K are strongly seen, as are the members of the $d_{\frac{3}{2}}^{-1}p_{\frac{3}{2}}^{1}$ configuration. The ground state is the only positive-parity state observed. (D.C.W.)

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Refer also to abstracts 8238, 8579, 9929, 9930, 9956, 9984, 10075, 10080, 10087, 10095, and 10102.

9995 (AEEW-M-504) NEUTRON CROSS-SECTIONS FOR NATURAL ZIRCONIUM IN THE ENERGY RANGE 0.0001 eV TO 6 keV. Pope, A. L. (Atomic Energy Establishment, Winfrith (England)). Sept. 1966. 26p. Dep. mn.

The available resolved resonance data for the isotopes of zirconium are evaluated, with the view to compile a file of basic tabulated neutron cross-section data. These data are also compared with integrally measured data; and from the discrepancies it is concluded that there is a need for better measurements of the radiation widths of the resonances for all zirconium isotopes, especially for the s-wave resonances of ^{91}Zr; that the measured values of the thermal neutron capture cross sections of the isotopes are not consistent with the data for natural zirconium; and that there are still considerable uncertainties in the resonance absorption integrals both for natural zirconium and the separated isotopes. (auth)

9996 (IA-1094) BASIC NUCLEAR DATA FOR THE HIGH PLUTONIUM ISOTOPES. PART I. CROSS SECTIONS. Segev, M.; Caner, M.; Yiftah, S. (Israel Atomic Energy Commission, Yavne. Soreq Nuclear Research Center). June 1966. 27p. Dep. mn.

Energy-dependent cross sections of ^{240}Pu, ^{241}Pu, and ^{242}Pu, in the range from 1 keV to 15 MeV, are constructed from the scant available experimental data by interpolation, extrapolation, general theoretical arguments and systematics. The constructed cross sections are presented in graphical form in 14 figures. (auth)

9997 (JINR-E4-3025) SPIN-QUADRUPOLE FORCES AND COLLECTIVE STATES IN DEFORMED NUCLEI. I. O^+ STATES. Chernej, M. I.; Pyatov, N. I.; Zheleznova, K. M. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1966. 28p. Dep. mn.

The residual spin-quadrupole interaction effects in collective motion of deformed nuclei are considered. An equation for the energy of 0^+ and 2^+ collective states is derived using the approximate second quantization method. Pairing and quadrupole as well as spin-quadrupole interactions are taken into account. The appearance of a new branch of collective excitations below the two-quasi-particle energy is predicted. The decay properties and the structure of the collective states are studied. The energies and E2 transition probabilities for 0^+ states are calculated for nuclei in the region $150 \leq A \leq 174$. (auth)

9998 (JINR-E3-3029) ALPHA DECAY AFTER RESONANCE NEUTRON CAPTURE BY SAMARIUM AND NEODYMIUM. Kvitek, J., Popov, Yu P. (Joint Inst. for Nuclear Research, Dubna (USSR) Lab. of Neutron Physics). 1966. 9p. Dep. mn.

The (n,α) reaction on samarium, neodymium, and isotopically enriched ^{149}Nd targets was investigated at neutron energies up to 400 eV. The α-particle widths for many individual resonances of ^{143}Nd, ^{145}Nd, ^{147}Sm, and ^{149}Sm were measured. The dependence of these widths on the spin of compound-nucleus excited states is clearly revealed in the results. The average α-particle widths of these isotopes are compared with theoretical predictions. (auth)

9999 (JINR-P6-2979) ISSLEDOVANIE GAMMA-IZLUCHENIYA ^{182}Ta NA POLUPROVODNIKOVOM SPEKTROMETRE. (Investigation of ^{182}Ta γ-Irradiation by Using a Semiconductor Spectrometer). Voinova, N.; Vrzal, Ya.; Dzhelepov, B.; Liptak, Ya.; Urbanets, Ya. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Neutron Physics). 1966. 36p. (In Russian). Dep. mn.

The gamma spectrum of ^{182}Ta for the energy range 50 to 1500 keV was investigated using a semiconductor spectrometer with a Ge(Li) detector. All previously known ^{182}T γ transitions were observed; their relative intensities were determined. The results obtained are in satisfactory agreement with those from previous observations. The values of conversion coefficients and multipolarities of the observed transitions were determined. The intensity balance of the γ transitions between ^{182}W levels was obtained. The intensities of β^- components and the values of log ft were found. (auth)

10000 (JINR-P7-3022) SINTEZ IZOTOPOV FERMIYA S MASSOVYMI CHISLAMI 247 I 246. (Synthesis of Fm Isotopes with Mass Numbers 247 and 246). Ilyushchenko, V. I.; Miller, M. B.; Mikheev, V. L.; Polikanov, S. M.; Shchegolev, V. A. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Reactions). 1966. 10p. (In Russian). Dep. mn.

In the nuclear reactions ^{239}Pu(C-12,4n)^{247}Fm and ^{239}Pu(C-12,5n) ^{246}Fm, the ^{247}Fm and ^{246}Fm isotopes were synthesized. Their radioactive properties were studied. For ^{246}Fm $E_\alpha = 8.25 \pm 0.03$ MeV and $T_{\frac{1}{2}} = 1.6 \pm 0.4$ sec ^{247}Fm has two alpha lines, one with $E_\alpha = 7.87 \pm 0.05$ MeV (~70%) and $E_\alpha = 7.93 \pm 0.05$ MeV (~30%) and a half life of 35 ± 4 sec and another with $E_\alpha = 8.18 \pm 0.03$ MeV and $T_{\frac{1}{2}} = 9.2 \pm 2.3$ sec. One of these states is, apparently, isomeric. Some assumptions are made on the possibility of isomeric state formation, which is connected with the $J_{\frac{1}{2}}$ level for isotopes with N = 147. (auth)

10001 (JINR-P7-3059) SINTEZ IZOTOPOV 102 ELEMENTA S MASSOVYMI CHISLAMI 256 I 255 V REAKTSIYAKH S IONAMI KISLORODA. (Synthesis of 102 Isotopes with Mass Numbers 256 and 255 in Reactions Induced by O Ions). Flerov, G. N.; Polikanov, S. M.; Mikheev, V. L.; Ilyushchenko, V. I.; Kushniruk, V. F.; Miller, M. B.; Sukhov, A. M.; Shchegolev, V. A. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Reactions). 1966. 13p. (In Russian). Dep. mn.

In bombarding ^{242}Pu with ^{18}O ions, the following isotopes ^{256}102 ($T_{\frac{1}{2}} = 9 \pm 3$ sec, $E_\alpha = 8.42 \pm 0.03$ MeV) and ^{255}102 ($T_{\frac{1}{2}} = 180 \pm 40$ sec, $E_\alpha = 8.09 \pm 0.03$ MeV) were synthesized. They were identified by excitation functions in nuclear reactions. The results obtained are in good agreement with those obtained in bombarding ^{238}U with ^{22}Ne. (auth)

10002 (JINR-P7-3041) SPEKTRY I UGLOVYE RASPREDELENIYA α-CHASTITS OT VZAIMODEISTVIYA USKORENNYKH IONOV ^{22}Ne, ^{40}Ar S YADRAMI Au, Th. (Spectra and Angular Distributions of α Particles from the Interaction of Accelerated ^{22}Ne and ^{40}Ar Ions with Au and Th Nuclei). Kapustsik, A.; Perelygin, V. P.; Tret'yakova, S. P.; Ukraintseva, L. V. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Reactions). 1966. 23p. (In Russian). Dep. mn.

Spectra and angular distributions of α particles from the interaction of ^{22}Ne ions with Au nuclei at 110 and 120 MeV and with Th nuclei at 115 and 140 MeV, as well as from the interaction of ^{40}Ar ions with Th nuclei at 240 MeV, were measured. In the spectra and angular distributions of the α particles one can clearly distinguish between the components corresponding to evaporation from the compound nucleus and direct processes. (auth)

10003 (JINR-P7-3065) IZOMERNYE OTNOSHENIYA V YADERNYKH REAKTSIYAKH PRIVODYASHCHIKH K IZOTOPAM ^{190}Ir, ^{196}Au, I ^{242}Am. (Isomeric Cross Section Ratios in Nuclear Reaction Leading to ^{190}Ir, ^{196}Au, and ^{242}Am). Flerov, G. N.; Gangrskii, Yu. P.; Markov, B. N.; Pleve, A. A.; Polikanov, S. M.; Yungklaussen, Kh. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Reactions). 1966. 13p. (In Russian). Dep. mn.

Isomeric cross section ratios in nuclear reactions leading to ^{190}Ir, ^{196}Au, and ^{242}Am were investigated. The dependences of these ratios on the average angular momentum were obtained. It is concluded that the spin of the spontaneously fissionable isomer ^{242}Am is small. (auth)

10004 (LA-3586) FISSION CROSS SECTIONS FROM PETREL. (Los Alamos Scientific Lab., N. Mex.). Sept. 19, 1966. Contract W-7405-eng-36. 231p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Fission data obtained in the Petrel event of June 11, 1965, are presented graphically and in tables, including calculated standard deviations. The isotopes studied were ^{233}U, ^{235}U, ^{239}Pu, ^{240}Pu, ^{241}Pu, ^{241}Am, and ^{242}Am; the neutron energy range covered for most isotopes was 20 eV to 1 MeV. (auth)

10005 (NAA-SR-Memo-12164) EFFECTIVE INTEGRALS AND ATTENUATION FACTORS FOR GOLD. Beller, L. S.; Farrar IV, H. (Atomics International, Canoga Park, Calif.). Sept. 20, 1966. Contract AT(11-1)-Gen-8. 97p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Measurements of the effective resonance integral, thermal and epithermal self-shielding factors, and cadmium ratios for ^{197}Au in 1/E neutron flux spectra are presented. The range of measurement covers over four decades in surface/mass ratio to provide a quantitative check on the validity of analytical calculations of these quantities. Apparatus, methods, procedures, and corrections are discussed. The results are in excellent agreement both with corrected analytical calculations by the TRIX-I code and with Monte Carlo calculations by the TRAFE code. Corrected TRIX-I calculations agree with the measurements to within a mean of 2.87% for eleven measured points covering four decades. (auth)

10006 (ORO-2843-11) NUCLEAR CHEMISTRY GROUP PROGRESS REPORT, 1966. (Florida Univ., Gainesville). Contract AT(40-1)-2843. 15p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Angular correlations of ternary fission and of fission-fragment scattering were investigated, and preliminary experiments were carried out on the characteristics of the ternary fission of ^{252}Cf,

^{240}Pu, ^{242}Pu, ^{234}U, and ^{236}U. A time-of-flight fission-fragment mass spectrometer was developed, as was a six-parameter multichannel analyzer and position-indicating solid-state detectors. (D.C.W.)

10007 (PUC-937-217) HIGH RESOLUTION STUDIES OF THE GAMMA-RAYS FROM ISOMERIC STATES WITH HALF-LIVES OF 10 μs-30 ms IN NUCLEI WITH Z = 63-83. Conlon, Thomas W. (Princeton Univ., N. J. Palmer Physical Lab.). July 1966. Contract AT(30-1)-937. 202p. Dep. mn. CFSTI $6.00 cy, $1.25 mn.

Thesis.

Isomeric states with half lives between 10 μs and 30 ms in the atomic number range 63 ≤ Z ≤ 83 were excited principally by the (p,n) and (p,2n) reactions, using 17.5 MeV protons. The gamma rays involved in the decay of the isomeric states were measured using a lithium-drifted germanium detector. Nine new isomers were produced which have half lives in the quoted range. For six of these, the isomeric nucleus has been uniquely identified and the multipolarities of the gamma-rays involved have in most cases been assigned. These isomeric nuclei and the measured value of the half lives (in microseconds) are: ^{153}Gd, 75.8; ^{159}Dy, 122.3; ^{165}Tm, 80.3; ^{172}Lu, 434; ^{191}Pt, 107; and ^{207}Bi, 174. The decay of the isomeric states in ^{159}Dy and ^{207}Bi give rise to particularly complicated spectra; in each case about ten gamma rays are involved. A unique scheme for the decay of the ^{159}Dy isomer has been established; for the ^{207}Bi isomer, a level scheme has been constructed which is consistent with the intensities and energies of the observed transitions. The remaining three new isomers were observed following bombardment of Gd, Hf, and ^{208}Pb; their respective half lives are: 180, 6.1×10^3, 500 μs. Fourteen isomers which have been previously reported were excited in this work. The isomeric nuclei together with the half lives in microseconds are: ^{151}Eu, 62.7; ^{153}Tb, 190; ^{173}Lu, 87.5; ^{175}Hf, 54; ^{181}Ta, 22.0; ^{180}W, 5.53×10^3; ^{181}W, 16.0; ^{187}Os, 31; ^{187}Ir, 29×10^3; ^{189}Ir, 12.3×10^3; ^{190}Tl, 29.2×10^3; ^{200}Tl, 33×10^3; ^{201}Tl, 2.7×10^3; and ^{206}Pb, 142. In almost all of these cases, the precision of the known transition energies and known half lives were greatly improved. The multipolarities of the transitions involved and the identity of the isomeric nuclei have been verified. The origin of the isomeric states are discussed principally in terms of the Nilsson model for odd-A nuclei. By considering the Nilsson states available to the last two particles, the isomerism in the even-A nuclei ^{172}Lu and ^{180}W can be understood. A state which may be described by the coupling of three particles, each described by Nilsson orbitals is suggested to explain the observed isomer in ^{159}Dy. Reduced matrix elements were extracted for the isomeric transitions and were examined to bring out possible systematic effects. (S.F.L.)

10008 (UCD-CNL-67) ANNUAL REPORT [ON NUCLEAR PHYSICS]. Jungerman, John A.; True, William W. (California Univ., Davis. Crocker Nuclear Lab.). Aug. 22, 1966. Contract AT-11-1-GEN-10. 47p. Dep. mn. CFSTI $2.00 cy, $0.50 mn.

Energy levels of ^{145}Sm were investigated by the decay of ^{145}Eu using a Ge(Li) spectrometer. The ^{145}Eu was produced with a 22-in. cylcotron by proton bombardment of ^{144}Sm. The level scheme and gamma transitions observed are presented. A study was begun on the decay of ^{211}Pb to ^{211}Bi in the interest of determining the spins of the 832 and 1104 keV states in ^{211}Bi. The NaI singles spectrum and the NaI coincidence spectrum gated by the 405 keV line is given for ^{211}Bi. (S.F.L.)

10009 (UCRL-16910) ENVIRONMENTAL EFFECTS ON THE DECAY CONSTANT OF ^{90m}Nb. Cooper, John A. (California Univ., Berkeley. Lawrence Radiation Lab.). Sept. 2, 1966. Contract W-7405-eng-48. 147p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Thesis.

A method was developed to study changes in nuclear decay constants due to alterations in the chemical or physical environment. This method was applied to the study of the effect of chemical state changes, the effect of a large increase in pressure, and the effect of changes into and out of the superconducting state on the decay constant of the 24-sec isomeric state in ^{90}Nb. The results showed that the energy of the transition depopulating this isomeric state is very low and that an appreciable fraction of the isomeric decay takes place by ejection of valence electrons. The gamma spectrum of ^{90}Mo was also investigated. Several previously unreported lines were observed, and the photon intensities were measured. The multipolarities of many of the intense transitions were determined and their coincidence relations were resolved with gamma-gamma coincidence studies. A decay scheme was postulated from which the energy of the transition depopulating the 24-sec isomeric state was determined from energy differences to be 2.38 ± 0.36 keV. (auth)

10010 (UCRL-16999) THE MAGNETIC MOMENT OF ^{239}Pu. Faust, John (California Univ., Berkeley. Lawrence Radiation Lab.). Aug. 4, 1966. Contract W-7405-eng-48. 63p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Thesis.

The triple-loop technique of atomic-beam magnetic resonance was used to determine the magnetic moment of ^{239}Pu directly. The final measurement was carried out at a magnetic field of 720 gauss and the magnetic moment was found to be $\mu_I = +0.200(4)$ nm (corrected), where the sign is measured to be positive. Hyperfine-structure measurements on ^{241}Pu, ^{185}W, and ^{187}W were attempted. These experiments involved the observation of four- and six-quantum transitions because of the inverted level ordering which was caused by the unusually large values of the quadrupole moments of all of these isotopes. (auth)

10011 (ANL-Trans-373) STUDIES ON THE RADIOACTIVATION BY THE ^{60}Co γ-RAY SOURCE. III. CROSS SECTIONS OF VARIOUS NUCLIDES FOR THE (γ,γ)-REACTION. Yoshihara, Kenji. Translated for Argonne National Lab., Ill., from Doitai To Hoshasen, 3: 472-82(1960). 19p. Dep. mn. JCL $1.60 fs, $0.80 mf.

Cross sections of various nuclides for the (γ,γ) reactions were measured, and from these values integrated cross sections were calculated. An integrated cross section is a characteristic constant for an activation level of a nuclide, and is not affected by energy distribution of incident γ ray. The integrated cross section concerning to the first activation level is $2.3 \pm 0.4 \times 10^{-31}$ cm^2 MeV for ^{115}In, $1.3 - 1.8 \times 100^{-31}$ cm^2 MeV for $^{107}Ag(^{109}Ag)$, $1.5 \pm 0.3 \times 10^{-31}$ cm^2 MeV for ^{111}Cd, and $2.2 \pm 1.1 \times 10^{-31}$ for ^{103}Rh, respectively. As the values of the activation levels are unknown for ^{87}Sr and ^{176}Lu, the integrated cross sections can not be calculated. In these cases, relative cross sections taking $^{115}In(\gamma,\gamma)$ ^{115}In reaction as a standard are given: 0.63 ± 0.15 for ^{87}Sr, and 30 – 60 for ^{176}Lu. The value for ^{176}Lu is anomalously high. (auth)

10012 A NOTE ON THE LEVEL STRUCTURE OF ^{210}Pb. Aggarwal, Gian (Panjab Agricultural Univ., Palampur, India); Kumar, Vijay. Curr. Sci. (India), 36: 41-2(Jan. 20, 1967).

The results of some shell-model calculations for the energy levels of ^{210}Pb, in which a Gaussian singlet-even interaction was used, are presented. (D.C.W.)

10013 ANGULAR DISTRIBUTION OF FRAGMENTS FROM ^{241}Am FISSION BY NEUTRONS. Vorotnikov, P. E.; Dubrovina, S. M.; Otroshchenko, G. A.; Shigin, V. A. Dokl. Akad. Nauk SSSR, 169: 314-15(July 11, 1966). (In Russian).

The angular distribution of fission fragments from the neutron fission of ^{241}Am was investigated; the results were correlated with similar data for ^{237}Np. (D.C.W.)

10014 MEASUREMENTS AND CALCULATIONS OF THE DOPPLER EFFECT ON THE REACTIONS $^{238}U(n,\gamma)$, $^{235}U(n,f)$, AND $^{239}Pu(n,f)$ WITH NEUTRONS IN THE ENERGY RANGE 0 TO 25 keV. Perkin, J. L.; Fieldhouse, P.; Brickstock, A.; Davies, A. R. (Atomic Weapons Research Establishment, Aldermaston, Eng.). J. Nucl. Energy: Pt. A and B, 20: 921-37(Nov. – Dec. 1966).

Spherical samples, 2 cm in diameter, of ^{238}U, ^{235}U and ^{239}Pu were irradiated in turn at various temperatures ranging from 170 to 770°K in a central cavity of a spherically symmetrical Sb – Be photoneutron source. The $^{238}U(n,\gamma)$ reaction rate was measured by counting the ^{239}U activity produced and the (n,f) reactions were monitored by counting the fission neutrons emitted. The spherical symmetry of the apparatus was chosen to minimize any effects of thermal expansion and to facilitate the comparison of the results obtained with those from a computer calculation based on a programme developed by Brissenden and Durston. In this program a statistical distribution of resonances based on resolved resonance data is tabulated over a fine energy mesh. This tabulation was used in a 4-region slowing down calculation resulting in a region-dependent neutron spectrum from which the particular reaction rates at various temperatures were obtained. (auth)

10015 THE REACTOR NEUTRON CAPTURE CROSS SECTION OF ^{124}Sb. Courtemanche, R.; Eastwood, T. A.; Werner, R. D. (Atomic Energy of Canada, Ltd., Ottawa. Atomic Energy of Canada, Ltd., Chalk River, Ont.). Can. J. Phys., 44: 2956-9 (Nov. 1966). (AECL-2493).

Samples of Sb were irradiated in a reactor, and the relative antimony-124 yields were measured. Gamma spectra of some samples were observed over extended periods of time following irradiation. The values obtained for the reactor neutron capture cross section are much smaller than the values reported previously. (D.C.W.)

10016 HALF-LIFE OF ^{132}I. Marais, P. G.; Haasbroek, F. J.; Heyns, C. F. G.; Karsten, J. H. M. (Fruit and Food Tech. Research Inst., Stellenbosch, S. Afr.). S. Afr. J. Agr. Sci., 9: 259-62(1966).

Iodine-132, extracted from tellurium-132, was used in studies on resolving time determinations of nucleonic apparatus, and its half life had to be known accurately. Although this isotope has now been available for more than a decade and is used extensively in

the medical fields, there is still no general agreement on its half-life. Using tellurium-132, adsorbed on aluminum oxide, iodine-132 was eluted from the column daily using 0.01M NH_4OH. Samples eluted on 2 dates were used for half-life determinations. Aliquots of these samples were added to solutions containing 30 ppM iodine carrier and sealed in glass containers which were placed inside Perspex tubes. The latter fitted tightly into the well of a well-type scintillation counter. The initial counting rates of the samples were 960,000 and 750,000 cpm, respectively. The scintillation counter was used under plateau conditions with the integral counting rates being recorded. Measurements commenced within 2 hr after the iodine-132 had been eluted, and the decay of both samples was followed for 12.4 hr. In both cases 125 evenly spaced readings were recorded. One-min readings were taken initially, but the time was increased progressively to 5.5 min as the samples decayed. The pooled half life for the 2 determinations was calculated; a value of 2.2846 ± 0.0004 hr was obtained. This value is believed to be considerably more accurate than any of the previously reported half lives for ^{132}I. (BBB)

10017 HALF-LIFE MEASUREMENTS IN ^{155}Gd. Malmskog, Sven G. (Aktiebolaget Atomenergi, Studsvik, Sweden). Ark. Fys., 33: 291-5(1966).

A half life of 6.48 ± 0.26 nsec was measured for the 86.5-keV level of ^{155}Gd using an electron-electron coincidence spectrometer and an ^{155}Eu source. This value is in agreement with values previously obtained using ^{155}Tb sources. The half life of the 105.4-keV level was measured to be 1.12 ± 0.05 nsec. (D.C.W.)

10018 THE NUCLEAR G-FACTOR OF THE 1301 keV 4^+-LEVEL IN ^{144}Nd. Johansson, K.; Joshi, M. C.; Karlsson, E.; Svensson, A. G. (Uppsala Univ.). Ark. Fys., 33: 329-35(1966).

The g-factor of the 1301-keV level in ^{144}Nd was measured using the method of perturbed angular correlations. The excitation of the level is briefly discussed. (D.C.W.)

10019 POSSIBLE ODD-PARITY STATE IN ^{128}Xe. Broman, Lars; Malmskog, Sven G. (Chalmers Univ. of Technology, Goteborg. Aktiebolaget Atomenergi, Studsvik, Sweden). Ark. Fys., 33: 323-7(1966).

Gamma lines in the decay of ^{128}I were measured using a Ge(Li) detector. The following gamma energies were obtained: 442.5 ± 0.5, 526.5 ± 0.5, 742.4 ± 1.0, 969.0 ± 1.0, and 1136.5 ± 2.0 keV. The 1136.5-keV transition defines a level in ^{128}Xe at 1579 ± 2 keV. From the log ft = 7.8 ± 0.3 of the β^- population, this level is believed to have an odd parity. Upper limits of gamma intensities for transitions around 530-keV are used to set a limit for the population of the expected O^+ level originating from the two-phonon quadrupole vibration. (auth)

10020 ABSOLUTE TRANSITION PROBABILITIES FROM THE 453.1-keV LEVEL IN ^{183}W. Malmskog, Sven G. (Aktiebolaget Atomenergi, Studsvik, Sweden). Ark. Fys., 33: 317-22 (1966). (AE-251).

The half life of the 453.1-keV level in ^{183}W was measured by the delayed coincidence method. The result determines 12 absolute E2 and M1 transition probabilities, of which nine are K-forbidden. All the transition probabilities are compared with single-particle predictions. The three K-allowed E2, $\Delta K = 2$ transition rates to the $9/2^-$ (512) rotational band are compared with the Nilsson model. An attempt was made to explain the observed transition rates by including the effects from admixtures into the single-particle wave functions. (auth)

10021 LIFETIME OF THE 5-keV $(3/2^+)$ LEVEL OF ^{171}Tm. Begzhanov, R. B.; Sadykov, Kh. M. (Inst. of Nuclear Physics, Uzbek SSR). JETP Lett. (USSR) (Engl. Transl.), 4: 294-5 (Nov. 15, 1966).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Redaktsiyu, 4: 436-9(Nov. 15, 1966).

The lifetimes of the 5.1 and 425.1-keV levels of ^{171}Tm from the decay of ^{171}Er were measured by observing γ-γ coincidences. The lifetime of the 8.4-keV level of ^{169}Tm was measured to check the operation of the equipment. Estimates were also obtained for the lifetimes of the first excited states of ^{199}Au and ^{161}Tb. (D.C.W.)

10022 SPONTANEOUSLY FISSIONING ISOMER WITH HALF-LIFE 10^{-7} SEC. Gangrskii, Yu. P.; Markov, B. N.; Polikanov, S. M.; Jungclaussen, H. (Joint Inst. for Nuclear Research, Dubna, USSR). JETP Lett. (USSR) (Engl. Transl.), 4: 289-90 (Nov. 15, 1966).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Redaktsiyu, 4: 429-31(Nov. 15, 1966).

A spontaneously fissioning isomer with a half life of 0.8 ± 0.3 × 10^{-7} sec was observed in the bombardment of ^{232}Th, ^{235}U, and ^{238}U with ^{12}C ions at 60 to 82 MeV. The isomer was identified with the isotope ^{246}Cf from the $^{238}U(C\text{-}12,4n)^{246}Cf$. (D.C.W.)

10023 STUDY OF THE RADIOACTIVE CHAIN OF MASS NUMBER 189. Fourrier, Alain; Jastrzebski, Jerzy; Kilcher, Pierrette; Paris, Pierre; Treherne, Jacqueline (Institut de Physique Nucleaire, Orsay, France). Compt. Rend., Ser. B, 263: 1182-5(Nov. 21, 1966). (In French).

By observation of the γ spectra of different isobars of mass number 189, the half life of ^{189}Hg was remeasured and was found to be equal to 8.4 ± 0.5 min. Two half lives were found in ^{189}Au: $T_{\frac{1}{2}}$ = 4.0 ± 0.3 min and $T_{\frac{1}{2}}$ = 28.7 ± 0.4 min. The relative intensities of the γ transitions were determined. (tr-auth)

10024 ON THE DECAY OF ^{152}Eu. Malmsten, Goeran; Nilsson, Oerjan; Andersson, Ingemar (Uppsala Univ.). Ark. Fys., 33: 361-70(1966).

The internal conversion electron spectrum from the decay of 12.4-yr ^{152}Eu was studied between 70 and 1500 keV using a 50-cm iron-free double-focusing spectrometer. Previously unreported transitions were found, and some previous uncertainties concerning the conversion were resolved. A table with energies and conversion electron intensities for the measured lines is given together with proposed level schemes for ^{152}Gd and ^{152}Sm. (auth)

10025 THE EFFECT OF BAND MIXING ON THE MULTIPLE COULOMB EXCITATION OF DEFORMED NUCLEI. Symons, G. D. (Univ. of Copenhagen); Douglas, A. C. Phys. Lett., 24B: 11-12(Jan. 9, 1967).

The effect of band mixing on the probability for multiple Coulomb excitation within the ground-state rotational band is studied. Recent data for ^{152}Sm are re-evaluated, and a limit is set on the magnitude of the angular-momentum dependence of the intrinsic quadrupole moment Q_0. (auth)

10026 LOW-LYING POSITIVE-PARITY STATES IN ODD INDIUM AND EVEN CADMIUM ISOTOPES. Bhatt, K. H. (Physical Research Lab., Ahmedabad, India). Phys. Lett., 24B: 22-4(Jan. 9, 1967).

The number of low-lying positive-parity states in odd In isotopes is much smaller than in odd Cd isotopes. A plausible implication of this fact is that first 2^+ state of an even Cd isotope is not a collective quadrupole phonon state of the nucleus. (auth)

10027 LOW-LYING ENERGY LEVELS OF ^{196}Pt. Jackson, H. E.; Julien, J.; Morgenstern, J.; Samour, C. (CEN, Saclay, France). Phys. Lett., 24B: 41-3(Jan. 9, 1967).

The γ spectrum from the β decay of ^{196}Au was studied with high resolution. The data, together with earlier (n,γ), (d,p), and (d,d') results, are combined to yield a new level scheme for ^{196}Pt. (auth)

10028 MULTIPLE NUCLEAR EXCITATION OF ROTATIONAL LEVELS IN ^{152}Sm AND ^{154}Sm. Harvey, B. G.; Hendrie, D. L.; Jarvis, O. N.; Mahoney, Jeannette; Valentin, J. (Univ. of California, Berkeley). Phys. Lett., 24B: 43-6(Jan. 9, 1967).

By observing the inelastic scattering of 50-MeV alpha particles from samarium, a definite correlation between reversed-phase angular distributions and double excitation of second excited rotational levels was made. For the first time, triple excitation of third excited rotational levels was observed. (auth)

10029 GAMMA-RAY INTENSITY ANOMALY IN THE (d,pγ) REACTION. Bartholomew, G. A. (Atomic Energy of Canada, Ltd., Chalk River, Ont.); Earl, E. D.; Ferguson, A. J.; Bergqvist, I. Phys. Lett., 24B: 47-9(Jan. 9, 1967).

Anomalously intense radiation was found near E_γ = 5 MeV in (d,pγ) γ spectra in elements near the 126 and 82 neutron shells. The analogue of this effect in (n,γ) spectra is well known. A possible explanation in terms of doorway states is suggested. (auth)

10030 FINE STRUCTURE IN THE NEUTRON TOTAL CROSS SECTION OF BISMUTH. Martin, R. C.; Yergin, P. F.; Winhold, E. J.; Medicus, H. A.; Augustson, R. H.; Kaushal, N. N.; Fullwood, R. R. (Rensselaer Polytechnic Inst., Troy, N. Y.). Phys. Lett., 24B: 33-4(Jan. 9, 1967).

The observation of fine structure in the neutron total cross section of ^{209}Bi in the energy region from 0.43 to 0.57 MeV shows that this nuclide is not in this respect essentially different from the adjacent Pb isotopes. (auth)

10031 A DECOUPLING EXPERIMENT ON THE α-γ CORRELATION IN ^{243}Am. Falk, F.; Toernkvist, S.; Thun, J. E.; Snellman, H.; Siegbahn, K.; Asaro, F. (Uppsala Univ.). Z. Phys., 198: 106-24(1967).

The directional correlation between α particles from the decay of ^{243}Am to the 75-keV level in ^{239}Np and the de-exciting 75-keV γ rays has been studied. The recoiling atoms were allowed to escape into vacuum. This brings about a strong hfs interaction between the heavily ionized daughter atom and the nuclear magnetic moment, which has been shown earlier to result in an almost isotropic correlation pattern. By the application of a magnetic field along the direction of the emission of the α-particles Asaro

and Siegbahn showed that the correlation pattern could be restored to, or almost to, the theoretical value, depending on the theory chosen. This is interpreted as a decoupling of the hfs-interaction, where the degree of decoupling is dependent on the strength of the applied field. The highest field used in the earlier experiment was 12 kG. For this experiment a decoupling magnet giving 24 kG was constructed. Applying this magnetic field on three different sources gave a result ($A_2 = -0.404 \pm 0.010$) which confirms the so called quadrupole correction of Chasman and Ramussen to the theory of Bohr et. al., of alpha decay of deformed nuclei. The decoupling magnet used in the experiment is described. (auth)

10032 STUDY OF THE γ RADIATIONS, WITH ENERGY BELOW 60 keV, EMITTED IN THE TRANSMUTATION OF ^{227}Th (RdAc) TO ^{223}Ra (AcX). Briancon, Chantal; Frilley, Marcel (CNRS, Orsay, France. Institut de Physique Nucleaire, Orsay, France). Compt. Rend., Ser. B, 263: 1261-3(Nov. 28, 1966). (In French).

The electron spectrum was studied by means of a semicircular magnetic spectrograph with and without preacceleration, and the photon spectrum by crystalline diffraction. Of the 13 radiations reported, 9 were observed for the first time. (tr-auth)

10033 INELASTIC SCATTERING OF IRON-CAPTURE GAMMA RAYS FROM THE 7.64-MeV LEVEL OF ^{112}Cd. Min, K. (Univ. of Virginia, Charlottesville). Phys. Rev., 152: 1062-7 (Dec. 16, 1966).

In the resonant-scattering experiment of the monochromatic iron-capture gamma rays from natural cadmium, five inelastically scattered photon groups were observed in addition to the 7.64-MeV elastic group. The spectrum of the low-energy cascade photons in coincidence with the scattered photons identifies the inelastic groups to be the transitions to the low-lying levels of ^{112}Cd, including the three 2^+ vibrational levels at 0.61, 1.29, and 1.46 MeV. Angular-distribution measurements show that the 7.64-MeV resonance level in ^{112}Cd has angular momentum 1. The average elastic-scattering cross section and the branching ratio for the ground-state transitions are $\langle\sigma_{\gamma\gamma}\rangle = 0.17 \pm 0.02$ b and $\Gamma_0/\Gamma = 0.48 \pm 0.06$, respectively. Using these values, the self-absorption measurements determined the ground-state transition width to be $\Gamma_0 = 0.6$ eV. (auth)

10034 TRANSVERSE POLARIZATION IN THE BETA DECAY OF ^{170}Tm. Braden, C. H.; Hungerford, E. V.; Patronis, E. T.; Wood, R. E.; Wyly, L. D. (Georgia Inst. of Tech., Atlanta). Phys. Rev., 152: 1068-72(Dec. 16, 1966).

In a series of experiments a careful attempt was made to measure the transverse polarization of the β particles in the 883-keV (log ft = 9.3) transition in ^{170}Tm. Mott-scattering techniques were used to detect the β polarization. The study shows that transverse-polarization measurements do not appear to be a fruitful way to delimit the matrix elements of transitions unless perhaps there is a marked deviation from the ξ-approximation calculations. The experimental value for the transverse polarization in the plane defined by the emitted β and γ particles, $P_{||} = -0.024 \pm 0.015$, is consistent with calculations from matrix elements satisfying the β-γ directional correlation coefficient and shape-correction factor. (auth)

10035 MEASUREMENT AND ANALYSIS OF THE ^{90}Zr(d,p)^{91}Zr REACTION BETWEEN 3.5 AND 5.5 MeV. Dally, E. B. (Institut de Recherches Nucleaires, Strasbourg); Nelson, J. B.; Smith, William R. Phys. Rev., 152: 1072-83(Dec. 16, 1966).

The reaction ^{90}Zr(d,p)^{91}Zr was studied for the cases leading to ^{91}Zr in the ground state (Q = 4.98 MeV) and the second (Q = 3.77 MeV), the sixth (Q = 2.91 MeV), and the eighth (Q = 2.42 MeV) excited states. Results are presented for the incident deuteron energies 3.5, 4.0, 4.5, 5.0, and 5.5 MeV. At most energies there is a complete angular distribution ranging from 20 to 160° in steps of 10°. A distorted-wave Born approximation analysis employing elastic-scattering parameters obtained from experiments in the region 11 to 16 MeV yielded good agreement with the angular shapes of the stripping data but not with their absolute magnitudes. (auth)

10036 LEVEL STRUCTURE OF ^{164}Dy FROM THE REACTION ^{163}Dy(n,γ)^{164}Dy. Hafemeister, D. W.; Shera, E. Brooks (Los Alamos Scientific Lab., N. Mex.). Phys. Rev., 152: 1084-7 (Dec. 16, 1966). (LA-DC-8026).

Gamma rays from the reaction ^{163}Dy(n,γ)^{164}Dy were observed with a Ge(Li) spectrometer operated in the pair mode. Transitions were observed from the capture state to the 2^+, 73.39-keV and 4^+, 242.23-keV members of the ground-state rotational band; to the 2^+, 761.80-keV and 3^+, 828.2-keV, members of the $K^\pi = 2^+$ gamma-vibrational band; and to the 2^-, 976.9-keV and 3^-, 1039.3-keV members of the $K^\pi = 2^-$ octupole band. Transitions to the 4^+ member of the gamma band and to the 4^- member of the octupole band were not observed. In order to explain this anomalous gamma branching, it is hypothesized that the capture-state wave function contains components with well-defined K values. (auth)

10037 CHARGE DISTRIBUTION IN THE FISSION OF ^{237}Np AND ^{239}Pu WITH INTERMEDIATE-ENERGY HELIUM IONS. Wogman, N. A.; Powers, J. A.; Cobble, J. W. (Purdue Univ., Lafayette, Ind.). Phys. Rev., 152: 1088-95(Dec. 16, 1966). (COO-347-22).

The independent yields of ten fission products from the fission of ^{237}Np induced by 40.5-MeV helium ions and from the fission of ^{239}Pu induced by 32.0-MeV helium ions were measured radiochemically. The data can be interpreted in terms of the equal-charge-displacement (ECD) hypothesis, and less rigorously, by the constant-charge-ratio proposal. The most applicable mass equation for the determination of the ECD parameters was found to be a continuous non-shell-corrected function. Information on neutron yield as a function of fission-product mass was inferred from the charge division. There is no evidence from this research for a 50-proton shell effect on yields or for an isomeric state of ^{96}Nb. (auth)

10038 MASS DISTRIBUTION IN THE FISSION OF ^{237}Np AND ^{239}Pu BY INTERMEDIATE-ENERGY HELIUM IONS. Powers, J. A.; Wogman, N. A.; Cobble, J. W. (Purdue Univ., Lafayette, Ind.). Phys. Rev., 152: 1096-1102(Dec. 16, 1966). (COO-347-23).

Cross sections were determined for 25 representative fission products in the fission of ^{237}Np by 20.0-, 25.0-, 28.4-, 32.5-, 37.5-, and 40.5-MeV helium ions and for ^{239}Pu by 21.5- and 32.0-MeV helium ions. Mass distribution curves were constructed from the data, and the fission and total reaction cross sections were determined. Various nuclear parameters are calculated and are compared with other fission systems and with theory. (auth)

10039 MEASUREMENT OF THE AVERAGE NEUTRON YIELD PER FISSION FOR ^{242m}Am. Fultz, S. C.; Caldwell, J. T.; Berman, B. L.; Bramblett, R. L.; Kelly, M. A.; Wilson, H. D.; Coops, M. S.; Lougheed, R. W.; Evans, J. E.; Hoff, R. W. (Univ. of California, Livermore). Phys. Rev., 152: 1046-9(Dec. 16, 1966).

The average number of neutrons per thermal neutron fission, $\bar{\nu}$, was measured for ^{242m}Am using a spark-chamber fission detector and a paraffin-moderated neutron detector. The value obtained is 3.24 ± 0.12 neutrons per fission. To check the method, measurements also were made on ^{235}U and ^{233}U, which gave 2.43 ± 0.08 and 2.54 ± 0.04 neutrons per fission, respectively. (auth)

10040 DECAY PROPERTIES OF NEUTRON-DEFICIENT OSMIUM AND RHENIUM ISOTOPES. I. DECAY MODES OF ^{179}Re, ^{180}Re, ^{180}Os, AND ^{181}Os. Hofstetter, K. J.; Daly, P. J. (Purdue Univ., Lafayette, Ind.). Phys. Rev., 152: 1050-5 (Dec. 16, 1966).

Scintillation and semiconductor detectors were used to investigate the decay properties of neutron-deficient osmium and rhenium isotopes which were produced in proton and helium-ion bombardments of tantalum and tungsten targets. ^{179}Re decays by electron capture with a half-life of 19.7 ± 0.5 min; the energies and relative intensities of 14 γ rays emitted in ^{179}Re decay are reported. The positron decay branch previously assigned to 20-hr ^{180}Re was shown to occur in the decay of 13-hr ^{182}Re, and no evidence for a ^{180}Re isomer having a half-life longer than a few minutes was found. The existence of 2.45-min ^{180}Re was confirmed; it decays predominantly by electron capture with the emission of intense 902.2- and 103.6-keV γ rays. By establishing its genetic relation with 2.45-min ^{180}Re, a previously unreported isotope ^{180}Os, decaying by electron capture with a 21.7 ± 0.6 min half-life, was identified. The half-life for the electron-capture decay of ^{181}Os was determined to be 105 ± 3 min, in disagreement with previous values reported for this isotope. An intense 238.6-keV γ ray is characteristic of ^{181}Os decay, and the energies and relative intensities of other ^{181}Os γ rays are reported. Reasons are advanced for believing that the ^{179}Re, ^{180}Os, and ^{181}Os activities identified were observed previously by other workers, but were incorrectly assigned to ^{180}Re, ^{181}Os, and ^{183m}Os, respectively. (auth)

10041 COLLECTIVE EXCITATIONS IN NEUTRON-DEFICIENT BARIUM, XENON, AND CERIUM ISOTOPES. Clarkson, Jack E.; Diamond, R. M.; Stephens, F. S.; Perlman, I. (Univ. of California, Berkeley). Contract W-7405-eng-48. Nucl. Phys., A93: 272-88(1967). (UCRL-16974).

The collective excitations of some neutron-deficient barium, xenon, and cerium isotopes were studied with germanium counters. Various (heavy ion, xn) reactions were used to produce ^{126}Ba, ^{124}Ba, ^{122}Xe, ^{120}Xe, and ^{134}Ce. The decay of ^{134}Pr to ^{134}Ce, with a half life of 17 ± 2 min, was also studied. Partial level schemes for the ground-state rotational bands up to spin 8^+ or 10^+ are proposed for the nuclides investigated. The mean lifetime of the first excited state in ^{126}Ba was determined to be 270 ± 50 psec and, hence gives the deformation of ^{126}Ba as $\beta = 0.24 \pm 0.02$. The

implications of the rotational energies and spacings as related to deformation in this region are discussed. (auth)

10042 ANALYSIS OF INTERMEDIATE STRUCTURE IN TERMS OF LEVEL-PARAMETER STATISTICS. Monahan, J. E.; Elwyn, A. J. (Argonne National Lab., Ill.). Nucl. Phys., A93: 683-8(1967).

Intermediate structure observed in the neutron total cross sections of Mo and Sn is discussed in terms of expected statistical fluctuations of the widths and spacings of compound-nucleus levels. Although the observed amplitude of this structure can be explained by such fluctuations, the data show correlations that are significantly inconsistent with this interpretation. (auth)

10043 MAGNETIC AND QUADRUPOLE MOMENTS OF THE 22-keV STATE OF ^{149}Sm. Ofer, S.; Nowik, I. (Bell Telephone Labs., Inc., Murray Hill, N. J.). Nucl. Phys., A93: 689-91(1967).

Recoilless absorption measurements of the 22-keV γ rays of ^{149}Sm in $SmCl_3 \cdot 6H_2O$ yielded a value of 0.93 ± 0.01 for the ratio of the magnetic moments of the 22-keV state and the ground state of ^{149}Sm. (auth)

10044 THE ISOMER WITH SPIN 12 IN ^{196}Au. Wapstra, A. H.; Goudsmit, P. F. A.; Jansen, J. F. W.; Konijn, J.; Loebner, K. E. G.; Nijgh, G. J.; de Wit, S. A. (Instituut voor Kernphysisch Onderzoek, Amsterdam). Nucl. Phys., A93: 527-44(1967).

In the decay of the 12^- isomer in ^{196}Au, a group of levels with spins 8^+, 7^+, and 5^+ from one configuration and another group with spins 6^+ and 7^+ from another configuration is excited. The lowest excited level decays by a second isomeric transition to the 2^- ground state. Precise energies, multipole assignments, and transition probabilities are measured for all transitions involved. Shell-model assignments can be made for all excited states. (auth)

10045 EXPERIMENTAL VALUES OF INTERNAL-CONVERSION COEFFICIENTS OF NUCLEAR TRANSITIONS: TOTAL AND K-SHELL COEFFICIENTS AND L-SUBSHELL COEFFICIENT RATIOS. Hamilton, J. H. (Vanderbilt Univ., Nashville); Ramayya, A. V.; van Nooijen, B.; Albridge, R. G.; Zganjar, E. F.; Pancholi, S. C.; Hollander, J. M.; Shirley, V. S.; Lederer, C. M. Nucl. Data, Sect. A, 1: 521-602(Aug. 1966).

A tabulation is presented of experimentally measured values of internal-conversion coefficients for the K-shell, α_K, L-subshells (mostly ratios only, $L_1 : L_2 : L_3$), and for all shells, α_{total}. Results reported prior to November 1965, with uncertainties of ≤25%, are listed and compared with theoretical values. Transition energies and spins and parities of initial and final levels, when known, are included. The theoretical values were obtained from computer interpolation, and in some cases extrapolation, of the tables of Sliv and Band. A brief discussion of the methods of measuring conversion coefficients is given. (auth)

10046 DECAY SCHEMES OF 70-min ^{129g}Te AND 33-DAY ^{129m}Te. Berzins, G. (Michigan State Univ., East Lansing); Beyer, L. M.; Kelly, W. H.; Walters, W. B.; Gordon, G. E. Contract AT(30-1)-905. Nucl. Phys., A93: 456-80(1967). (MIT-905-73).

Gamma rays emitted in the decay of 70-min ^{129g}Te and 33-day ^{129m}Te were investigated with Ge(Li) and NaI(Tl) detectors. Results of Ge(Li)–NaI(Tl) coincidence studies, coupled with relative intensity measurements for both isomers, suggest a decay scheme considerably different from those recently proposed. Excited levels are placed in ^{129}I at 27.7, 278.4, 487.4, 559.8, 696.0, 729.8, 768.9, 829.8, 844.7, 1050, 1111.4, 1260, 1291 and 1402 keV. Beta decay of ^{129g}Te feeds all of these except the ones at 696.0, 729.8, 768.9, 844.7, 1050, and 1402 keV. Beta transitions from ^{129m}Te populate all of the latter set of levels and the ground state. The I.T. branching fraction of ^{129m}Te is about 72%. With some exceptions the levels of ^{129}I agree rather well with those predicted by Kisslinger and Sorensen. Considerable evidence for the previously suggested hindrance of β decay caused by phonon mixing of the wave functions was observed. (auth)

10047 EXPERIMENTAL STUDY OF THE EXCITED LEVELS OF ^{132}Xe. Henck, R.; Stab, L.; Siffert, P.; Coche, A. (Centre de Recherches Nucleaires, Strasbourg). Nucl. Phys., A93: 597-608(1967). (In French).

The γ spectrum of ^{132}I was studied with Ge(Li) γ spectrometers. The following previously unreported transitions were observed: 813 ± 2, 864 ± 3, 877 ± 2, 911 ± 2, 926 ± 3, 1034 ± 3, 1291 ± 2, 1296 ± 2, 1316 ± 2, 1828 ± 3, 2088 ± 3, 2250 ± 3, 2286 ± 3, 2445 ± 3, and 2524 ± 3 keV; the relative intensities were measured. Previously published values of relative K-electron intensities were used to obtain the conversion coefficients for the 263, 285, 504, 507, 523, 620, 630, 727, 729, 773, 955, 1138, and 1398 keV transitions. All are M1 and/or E2 except the 504(E1) and 729 (M2 or E3) keV transitions. The level scheme proposed by Hamilton, Boyd and Johnson is modified; the level at 2658 keV is suppressed, and levels are added at 2351, 2393, 2428, 2590, 2614.4, 2670 and 2892 keV. (auth)

10048 FAST NEUTRON SCATTERING FROM ELEMENTAL Mo, Sn, Sb, AND Te. Smith, A. B.; Hayes, R. (Argonne National Lab., Ill.). Nucl. Phys., A93: 609-30(1967).

Neutrons with incident energies of 0.3 to 1.5 MeV were scattered from elemental Mo, Sn, Sb, and Te. Fast time-of-flight techniques were employed to measure the differential elastic and the differential inelastic scattering cross sections at ≤25 keV increments throughout the incident neutron energy interval. The inelastic excitation of states, in Mo at 0.20 ± 0.01, 0.50 ± 0.04, 0.79 ± 0.06, and ≈1.05 MeV; in Sn at ≈1.2 MeV; in Sb at 0.037 ± 0.003, 0.16 ± 0.01, 0.54 ± 0.04, and ≈1.1 MeV; and in Te at 0.65 ± 0.02, 0.75 ± 0.02, and 0.85 ± 0.02 MeV was observed. The experimental results were compared with calculations based upon a surface absorption optical potential and the statistical theory of average compound-nucleus cross sections including width fluctuation corrections. These comparisons were related to the characteristics of the low-energy excited states of the respective nuclei and to the proton shell closure at Z = 50. (auth)

10049 THE $K^\pi = 0^+$ BANDS OF ^{178}Hf AND THE ALLOWED UNHINDERED BETA TRANSFORMATIONS OF 9.3-MIN ^{178}Ta AND 22-DAY ^{178}W. Nielsen, H. L. (Research Establishment, Riso, Denmark); Wilsky, K.; Zylicz, J.; Soerensen, G. Nucl. Phys., A93: 385-401(1967).

The decay of 22-day ^{178}W and 9.3-min ^{178}Ta (1^+) was investigated by means of direct and coincidence spectrometry with Ge(Li) and scintillation detectors. The Q-value of the electron-capture decay of ^{178}W was determined to be 89 ± 2 keV from the K-capture-to-total capture ratio. The corresponding log ft value is 4.65. The ground-state-to-ground-state beta decay rates were analyzed in light of the pair correlation scheme. Capture-to-positon ratios were deduced for ^{178}Ta and were found to agree with theory. Excited states in ^{178}Hf (characterized by their energy in keV, spin, and parity) were established at 1199(0^+), 1276(2^+), 1434(0^+), 1444 (0^+), 1496(2^+), 1514(2^+, 1^+, or 1^-), and 1561(2^+). The 1199-keV state is interpreted as a beta vibration; the 1434- and 1444-keV 0^+ states contain probably large amplitudes of the $^7/_2^-$[514] neutron pair or the $^9/_2^-$[514] proton pair (labelled by Nilsson quantum numbers $\Omega^\pi[Nn_zA]$). Energies and beta decay rates for the 0^+ states are compared with the calculations of Soloviev. The energy of the third excited 0^+ state is found to be much lower than this theory predicts. The first excited $K^\pi = 0^+$ band is less strongly fed in beta decay than the calculations predict. (auth)

10050 THE ANALYSIS OF THE LOW-LYING $0^{+\prime}$ STATES IN THE MEDIUM-WEIGHT NUCLEI. Kregar, M.; Mihailovic, M. V. (Univ. of Ljubljana, Yugoslavia. Stefan Nuclear Inst., Ljubljana, Yugoslavia). Nucl. Phys., A93: 402-16(1967).

The low-lying spectra of some medium-weight nuclei are analyzed in terms of the Davydov nonadiabatic model. It is shown that some critical data like $B(E2;0^{+\prime} \rightarrow 2^+)/B(E2;0^+ \rightarrow 2^+)$ and the effective γ deformation of nuclei as ^{70}Ge, ^{72}Ge, ^{74}Ge, ^{76}Se and perhaps other nuclei can be interpreted by means of the Davydov nonadiabatic model, where the $0^{+\prime}$ states belong to the oblate shape ellipsoid. (auth)

10051 NIOBIUM RESONANCE PARAMETERS. Lopez, W. M.; Haddad, E.; Friesenhahn, S. J.; Froehner, F. H. (General Atomic Div., General Dynamics Corp., San Diego, Calif.). Contract AT (04-3)-167. Nucl. Phys., A93: 340-56(1967).

Neutron resonances for niobium were investigated in the energy range 30 to 1400 eV using a 4000-l liquid scintillator capture γ detector and the time-of-flight method. Resonance parameters were deduced from capture and self-indication data. The average total radiation widths were found to be Γ_γ = 135 MeV for s-wave levels and Γ_γ = 170 MeV for p-wave levels. Radioactivity was observed in ^{94}Nb with a half life of ≈65 μsec and is thought to be due to an unidentified isomeric state. (auth)

10052 SHAPE OF THE ^{208}Pb NUCLEAR POTENTIAL. Dost, M. (Max-Planck-Institut fuer Kernphysik, Heidelberg); Hering, W. R.; Smith, William R. Nucl. Phys., A93: 357-69(1967).

The doubly closed-shell status of ^{208}Pb and the low Q-values associated with the ^{208}Pb(d,p)^{209}Pb reaction offer the possibility of determining the nuclear potential for the neutron by requiring that the same nonlocal Woods-Saxon potential reproduce both the stripping to various levels in ^{209}Pb and also the ^{207}Pb neutron hole and ^{209}Pb neutron energy-level positions. Such a potential was found by DWBA and shell-model calculations employing for stripping data the 135° ^{208}Pb(d,p)^{209}Pb stripping cross sections corresponding to the seven lowest levels in ^{209}Pb at a bombarding energy sufficiently low (8 MeV) that the nuclear potentials have influence only on the normalization of the captured neutron wave function. Except for the nonlocality range, the resulting potential is in good agreement with neutron elastic scattering predictions. (auth)

10053 COLLECTIVE VIBRATIONS IN ODD-MASS THALLIUM ISOTOPES. Covello, A.; Sartoris, G. (Rutgers–The State Univ. of New Jersey, New Brunswick). Nucl. Phys., A93: 481-500(1967).

The intermediate-coupling unified model is applied to the four odd-mass thallium isotopes ^{205}Tl, ^{203}Tl, ^{201}Tl, and ^{199}Tl. All the single-hole states within the shell ending at 82 and the core states up to three phonons are included in the model space. The spectra, the electromagnetic transition rates, and the static moments are calculated; and a trend for the variations of the parameters passing from one isotope to the next is established. Satisfactory agreement with the experimental data is obtained. (auth)

10054 COINCIDENCE STUDIES OF ^{131m}Te. Beyer, L. M.; Berzins, G.; Kelly, W. H. (Michigan State Univ., East Lansing). Nucl. Phys., A93: 436-55(1967).

The disintegration scheme of 30 h ^{131m}Te was investigated using NaI(Tl) and Ge(Li) detectors and a NaI(Tl)–Ge(Li) coincidence spectrometer. The high-resolution Ge(Li) detector was used to identify and accurately determine the energies of 45 gamma rays. Levels are established in ^{131}I at energies of 149.7, 493, 603, 773.7, 852.1, 1059.7, 1315, 1556.2, 1596.5, 1646, 1797, 1888, 1899, 1980, 2001, 2168, and 2270 keV. These states accommodate all but six very weak transitions. Energy sums and relative intensity measurements were used to confirm the scheme. (auth)

10055 INTERMEDIATE COUPLING APPROACH IN THE UNIFIED NUCLEAR MODEL. I. ODD-MASS Pm NUCLEI. Choudhury, D. C.; O'Dwyer, T. F. (Polytechnic Inst. of Brooklyn). Nucl. Phys., A93: 300-20(1967).

The properties of the low-lying levels of the odd-mass promethium isotopes are investigated within the framework of the intermediate coupling approach in the unified nuclear model. It is assumed that the last odd proton has available to it the $1g_{\frac{9}{2}}$ and $2d_{\frac{5}{2}}$ states and is coupled to the collective surface vibrations of the doubly even core of the nucleus. The resulting Hamiltonian of the coupled system is diagonalized including all states with up to three phonons of the quadrupole vibrations. Using reasonable values for the coupling strength and for the "effective" spacing in energy between the $g_{\frac{9}{2}}$ and $d_{\frac{5}{2}}$ states, the low-lying energy levels of ^{145}Pm, ^{147}Pm, and ^{149}Pm are calculated. These are in fairly good agreement with experimental data. The electromagnetic transition probabilities and the nuclear moments are calculated using the wave functions obtained. In most cases these results are also in substantial agreement with the experimentally observed values. Finally, the validity of the approximations used in the present analysis and the possible reasons for some of the discrepancies between the theoretical and experimental results are discussed. (auth)

10056 THEORETICAL STUDY OF THE REACTION ^{204}Pb(t, p)^{206}Pb. Broglia, R. A.; Riedel, C. (Univ. of Copenhagen). Nucl. Phys., A93: 241-51(1967).

Angular distributions and relative intensities for final states below 4 MeV in the ^{204}Pb(t,p)^{206}Pb reaction are calculated. These levels are described by means of two holes and one-particle, three-hole shell-model wave functions. The ^{206}Pb states at 2.65 MeV and 3.78 MeV correspond to the 3^- and 5^- levels strongly excited in the reaction ^{206}Pb(t,p)^{208}Pb. (auth)

10057 FERMI-FUNCTION INTEGRALS FOR FINDING RELATIVE BETA-GROUP INTENSITIES. Ford, George P.; Hoffman, Darleane C . (Los Alamos Scientific Lab., N. Mex.). Nucl. Data, Sect. A, 1: 411-33(July 1966).

Values are presented of the definite integral $I(Z,T_{max})$, which is related to the relative number, N, of electrons in a β^--group with end point energy T_{max} by the simple expression $N = \alpha^2 T_{max}^2 I(Z,T_{max})$, where α is the y-intercept in the Fermi-Kurie plot, $I(Z,T_{max}) = \int_0^{T_{max}} f(Z,T)h(T)dT$, where f is the Fermi function and $h(T) = (T+1)(1 - T/T_{max})^2[T(T+2)]^{-\frac{1}{2}}T_{max}^{-2}$. The Z-range is 10(1)109; the T_{max}-range is 0.1(0.05)0.4, 0.5(0.1)5.2. (auth)

10058 ALPHA RADIOACTIVE ISOTOPES OF PROTACTINIUM. Briand, J. P.; Chevallier, P. (Institut du Radium, Paris). pp 31-6 of Physico-Chimie du Protactinium. Paris, Centre National de la Recherche Scientifique, 1966. (In French).

A method of identification of protactinium isotopes decaying by α emission is briefly exposed. The α decay of ^{230}Pa was observed. Some of its fine structure lines are indicated. (auth)

10059 STRUCTURE OF THE EXCITED LEVELS OF ^{234}Pa. Foucher, R. (Institut du Radium, Orsay, France). pp 27-9 of Physico-Chimie du Protactinium. Paris, Centre National de la Recherche Scientifique, 1966. (In French).

The characteristics of the low-energy excited levels of the ^{234}Pa nucleus, energies, angular momenta, meanlives were experimentally determined and theoretically predicted from the "independent particle" nuclear model of S. G. Nilsson. The comparison between experimental and theoretical results confirmed the validity of the model for heavy atomic nuclei far from "magic nuclei" and having an odd number of protons and neutrons. (auth)

10060 DECAY PROPERTIES OF ^{244}Pu, AND COMMENTS ON ITS EXISTENCE IN NATURE. Fields, P. R. (Argonne National Lab., Ill.); Friedman, A. M.; Milsted, J.; Lerner, J.; Stevens, C. M.; Metta, D.; Sabine, W. K. Nature, 212: 131-4(Oct. 8, 1966).

Because of current interest in the nuclear properties of ^{244}Pu, the alpha and spontaneous fission half lives of this nuclide were redetermined and its alpha particle spectrum, using samples highly enriched in ^{244}Pu by means of the ANL electromagnetic isotope separator, was observed. A search for naturally occurring ^{244}Pu in gadolinite was carried out, and an experimental upper limit for its present average terrestrial abundance was established. (W.D.M.)

10061 THE LIFETIME OF THE 226.9-keV LEVEL IN ^{155}Tb. Bedrosyan, P.; Kuchma, A. S.; Morozov, V. A. Yadern. Fiz., 4: 905-8(Nov. 1966). (In Russian).

A ^{155}Dy source was used in the measurements. Coincidences of the 226.9-keV transition with high-energy γ-quanta in the region of 665 keV were analyzed. The half life of the 226.9-keV level was found to be $T_{\frac{1}{2}\gamma} = (3.4 \pm 0.5) \times 10^{-10}$ sec, and the Weisskopf and Nilsson delay factors are $F_W = 0.7 \times 10^4$ and $F_N = 0.49$, respectively. (auth)

10062 THE HALF LIVES OF THE 243-keV AND 188-keV LEVELS IN ^{125}I. Horowitz, Y. S.; Moore, R. B.; Barton, R. (McGill Univ., Montreal). Can. J. Phys., 45: 101-6(Jan. 1967).

The half lives of 243-keV and 188-keV levels in ^{125}I were measured, yielding $T_{\frac{1}{2}} = 2.1 \pm 0.2 \times 10^{-10}$ sec for the 243-keV level and $T_{\frac{1}{2}} = 3.4 \pm 0.2 \times 10^{-10}$ sec for the 188-keV level. Partial half lives were calculated, indicating that the E2 transition rates are enhanced over single-particle estimates by a factor of 30 and hence are collective in nature. (auth)

10063 GAMMA RAYS FROM THERMAL AND RESONANCE NEUTRON CAPTURE IN GOLD. Wetzel, K. J.; Bockelman, C. K.; Wasson, O. A. (Yale Univ., New Haven). Nucl. Phys., A92: 696-704(1967).

A lithium-drifted germanium detector was used to measure the high-energy gamma rays following thermal and resonance neutron capture in gold. In the region $E_\gamma \geq 5.08$ MeV, many new transitions are resolved, and transition intensities as well as level excitations are given. A level scheme deduced from these data does not agree with one proposed on the basis of low-energy, gamma-ray measurements. A comparison of the spectrum following capture in the 4.9 eV resonance with that following thermal neutron capture shows that no significant change in the relative intensity of individual gamma rays occurs. (auth)

10064 MECHANISM OF PROTON–TRANSFER REACTIONS. Volkov, V. V.; Wilczynski, J. (Joint Inst. for Nuclear Research, Dubna, USSR). Nucl. Phys., A92: 495-504(1967).

The proton-transfer reaction (^{12}C, ^{13}N) on ^{12}C, ^{27}Al, ^{51}V, ^{93}Nb, ^{107}Ag, ^{109}Ag, and ^{181}Ta target nuclei was investigated. The angular distributions at different energies well above the Coulomb barrier were measured. Distinct differences between the neutron- and proton-transfer reactions were revealed. The proton-transfer cross section rapidly reduces with the increasing atomic number of the target. Moreover, the excitation functions decrease with decreasing energy faster than in the case of neutron transfer. The analysis of the experimental data, based on the single-transfer reaction models of Frahn and Venter and of Kalinkin and Grabowski shows these differences. The observed specific behavior of the proton-transfer reactions may be due to the Coulomb polarization of the proton wave functions. (auth)

10065 CORRELATION OF FISSION FRAGMENT KINETIC ENERGY DATA. Viola, V. E. Jr. (Argonne National Lab., Ill.). Nucl. Data, Sect. A, 1: 391-410(July 1966).

Recent measurements of the most probable kinetic energy release in fission are compared in order to study the dependence on nuclear species. Appropriate corrections to data obtained with semi-conductor detectors, particularly with regard to calibration procedures, are discussed and applied. Corrected results are listed in a table and are plotted. It is found that the most probable kinetic energy release in fission can be simply expressed by the function $\langle E_k \rangle = 0.1071Z^2/A^{1/3} + 22.2$ MeV. The corrected $\langle E_k \rangle$ values are compared with recent liquid-drop calculations and good agreement is found for Z^2/A less than 35, but not above this value. Effects of mass asymmetry are also briefly discussed. Analysis of the data indicates that the most probable kinetic energy release is essentially independent of excitation energy. Use was made only of results published since 1961. Prior data can be found in the review of Huizenga and Vandenbosch [Nuclear Reactions, Vol. II, Nu-

clear Fission (North-Holland Publishing Co., Amsterdam, 1962)]. (auth)

10066 ENERGY DEPENDENCE OF THE ANGULAR DISTRIBUTION OF FRAGMENTS IN THE NEUTRON FISSION OF ^{233}U, ^{235}U, AND ^{239}Pu. Nesterov, V. G.; Smirenkin, G. N.; Shpak, D. L. Yadern. Fiz., 4: 993-1001(Nov. 1966). (In Russian).

Results of angular distribution measurements in the neutron fission of ^{233}U, ^{235}U and ^{239}Pu are given. The measurements for ^{233}U and ^{239}Pu were performed using 0.08 to 1.5 MeV neutrons, and ^{235}U using 0.08 to 6 MeV neutrons. The data are discussed on the basis of the existing concepts concerning the excited-state spectrum of the transient nucleus. (auth)

10067 VELOCITIES OF RESIDUAL NUCLEI IN THE FISSION OF Ag AND Br BY 460-MeV PROTONS. Afanasev, B. P.; Gismatullin, Yu. R.; Ostroumov, V. I. (Leningrad Polytechnic Inst.). Yadern. Fiz., 4: 1002-9(Nov. 1966). (In Russian).

The tracks of recoil nuclei were investigated in the disintegration of heavy emulsion nuclei by 460-MeV protons. The values of the longitudinal and transversal components of the nuclear velocity were obtained at various excitation energies. The recoil effect was calculated for the thermal emission of neutrons, protons, ^{2}H, ^{3}H and ^{4}He nuclei, corresponding to the nuclear temperatures 1 to 6 MeV. The value for the mean longitudinal nuclear velocity component was found to be smaller for disintegrations with high excitation energy than follows from cascade process calculations, according to the Serber model. (auth)

10068 CROSS SECTIONS FOR THE FISSION OF ^{238}Pu AND ^{241}Am BY MONOCHROMATIC RESONANCE NEUTRONS. Gerasimov, V. F. Yadern. Fiz., 4: 985-92(Nov. 1966). (In Russian).

The fission cross sections for ^{238}Pu and ^{241}Am were measured in the energy ranges 0.02 to 400 eV and 0.02 to 50 eV, respectively. The $\sigma_{of}\Gamma$ values were determined for five levels below 100 eV in ^{238}Pu. The parameters Γ_f/Γ were determined for 13 levels in ^{241}Am for energies $E_n < 15$ eV. (auth)

10069 XENON YIELDS IN THE FISSION OF HEAVY ELEMENTS BY MEDIUM-ENERGY PROTONS. Forster, J. H.; Porile, N. T.; Yaffe, Y. (McGill Univ., Montreal). Can. J. Chem., 44: 2951-72(Dec. 15, 1966).

Independent yields for ^{133}Xe and ^{135}Xe cumulative yields for ^{133}I and ^{135}I in fission of ^{233}U, ^{235}U, ^{238}U, and ^{232}Th by protons with energies 20 to 85 MeV were measured. Values of Z_p, the most probable charge, were obtained by two different methods. The behavior of Z_p for ^{235}U and ^{233}U differed considerably from that of ^{238}U and ^{232}Th. Total chain yields were obtained for A = 133 and A = 135. (auth)

10070 RADIOCHEMICAL AND SPECTROSCOPIC STUDIES OF NUCLEAR EXCITATIONS IN EVEN ISOTOPES OF THE HEAVIEST ELEMENTS. Bjoernholm, S. Copenhagen, Munksgaard, 1965. 79p.

A survey of radiochemical and spectroscopic studies of excitations in heavy even nuclei is presented. The theoretical description of low-energy excitations is covered, as are experimental methods and observations. 67 references. (D.C.W.)

10071 PARAMETERS OF THE STRUCTURE OF THE NEUTRON STRENGTH FUNCTION OF MEDIUM AND HEAVY NUCLEI. Sukhoruchkin, S. I. (Inst. of Theoretical and Experimental Physics, Moscow). Vienna, International Atomic Energy Agency, 1966, Preprint No. CN-23/105, 8p. (In Russian). (CONF-661014-30). DTIE.

From IAEA Conference on Nuclear Data, Paris.

In order to obtain reliable values of strength functions when averaging the neutron widths of individual resonances it is necessary to fulfil the condition that the averaging interval exceed the characteristic energy period of modulation of the neutron widths, which is related to single-particle effects in the entrance channel. The results of an analysis of the experimental data are presented with a view to determining the parameters of the single-particle structure of the neutron strength function. (auth)

Nuclear Theory

Refer also to abstracts 9927, 9928, 9937, 9997, 10029, 10055, and 10071.

10072 (AD-643812) MULTIPLE SCATTERING OF CHARGED PARTICLES. Marion, Jerry B.; Zimmerman, Barbara A. (California Inst. of Tech., Pasadena). Oct. 1966. Contract Nonr-220(47). 24p.

Numerical calculations were carried out for the multiple scattering of charged particles as described by the theories of Molière and of Nigam, Sundaresan, and Wu (NSW). The NSW theory is the more accurate, but the deviations from the older theory of Molière are not great. An approximation to the NSW theory is given which is shown to be essentially indistinguishable from the complete NSW theory for the scattering of medium-energy protons and which allows the construction of "universal" angular distribution curves. A method is given which permits the rapid evaluation of the angle at which the angular distribution has decreased to 1/e of its value in the forward direction. (auth)

10073 (GEMP-447) ABACUS-II (GE-625 VERSION). Edwards, M. R. (General Electric Co., Cincinnati, Ohio. Nuclear Materials and Propulsion Operation). Oct. 31, 1966. Contract AT(40-1)-2847. 137p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

A brief report verifying the conversion of ABACUS-II to Fortran IV for use on the GE-625 is presented. BNL-6562 contains a complete documentation of this code in Fortran II. (auth)

10074 (ORO-3346-8(Rev.)) COMPARISON WITH THEORY OF EXPERIMENTAL VALUES OF L-CAPTURE/K-CAPTURE RATIOS FOR ALLOWED AND FIRST-FORBIDDEN TRANSITIONS. Fink, R. W. (Georgia Inst. of Tech., Atlanta. School of Chemistry). Nov. 1966. Contract AT(40-1)-3346. 11p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Precise values of L/K capture ratios available in the literature up to November 1966 are compared with recent theoretical results. (auth)

10075 (UCRL-14955) FAST NEUTRON CROSS SECTIONS INFERRED FROM CHARGED-PARTICLE DATA AND FROM THE APPLICATION OF NUCLEAR MODELS. Anderson, John D.; Lutz, Harry F. (California Univ., Livermore. Lawrence Radiation Lab.). June 13, 1966. Contract W-7405-eng-48. 44p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The possibility of using charged-particle data together with various nuclear models to generate neutron data is studied. A general description of the interaction of nucleons with matter in terms of specific models (optical model, extended optical model, charge independence, and charge symmetry) is presented, along with sufficient data to indicate the general usefulness of the models in generating nuclear cross sections. (auth)

10076 (ANL-Trans-372) STUDIES OF THE RADIOACTIVATION OF THE ^{60}Co γ-RAY SOURCE. II. CONSIDERATION OF THE (γ,γ) REACTION BY THE USE OF A NON-SPHERICAL γ-RAY SOURCE. Yoshihara, Kenji. Translated for Argonne National Lab., Ill., from Doitai To Hoshasen, 3: 464-71(1960). 15p. Dep. mn. JCL $1.60 fs, $0.80 mf.

Applying the theory of a spherical source which was previously proposed, radioactivation by the use of a nonspherical γ source was considered. An over-all cross section of (γ,γ) reaction was calculated in the cases of a disc source and a cylindrical source. Kaminishi et al. calculated it in the case of a cylindrical source, but they did not consider weight fractions in calculating the mean cross section. For a thick source or intervening substances, it is necessary to correct the effect of multiple scattering, but this is a difficult problem to solve theoretically. Therefore, it is proposed that the dose buildup factor obtained experimentally is to be used to correct for it. (auth)

10077 (ANL-Trans-375) STUDIES ON THE RADIOACTIVATION BY THE ^{60}Co γ-RAY SOURCE. I. GENERAL CONSIDERATIONS ON THE RADIOACTIVATION BY THE USE OF A γ-RAY SOURCE OF RADIOISOTOPE. Yoshihara, Kenji. Translated for Argonne National Lab., Ill., from Doitai To Hoshasen, 3: 276-85(1960). 16p. Dep. mn. JCL $1.60 fs, $0.80 mf.

Radioactivation by use of a radioisotope γ source is treated on the basis of the theory of Compton scattering. The Klein–Nishina formula was applied to estimate the flux of the resonance γ ray effective for this activation reaction. The overall cross section (σ) of a nuclide for radioactivation is expressed as follows: $\sigma = \sigma_1 + \sigma_2 + \sigma_3 + \sigma_4$, where σ_1 is Compton scattering in the source itself, σ_2 is scattering by intermediate substances, σ_3 is the wall, and σ_4 is the target itself. The value for σ_3 can not be estimated generally because of the complexity of the wall effect. But the other three terms can be easily calculated using simplified models. Assuming a spherical source for calculation of σ_1, a formula was obtained, $\sigma_1 = K \cdot n_{01} \cdot \phi \cdot \sigma_a \cdot e^{(\mu_1 - \mu_1')R}(1 - e^{-\mu_1 R})/\mu_1$ and $K = e^{(\mu_2 - \mu_2')\rho}$, where n_{01} is an electron density per unit volume of the source substance, ϕ is the cross section of an electron for production of the γ ray effective for this activation reaction, σ is the activation cross section of the nuclide for the effective γ ray, μ_1 and μ_1' are the absorption coefficients of the source substance to the original γ ray and the resonance γ ray respectively, R is the radius of the source, μ_2 and μ_2' are the absorption coefficients of the intermediate substance to the original γ ray and the resonance γ ray, respectively, and ρ is the thickness of the intermediate substance. The equation for determining σ_2 is $\sigma_2 = n_{02} \cdot \phi \cdot \sigma_a(1 - e^{(\mu_2 - \mu_2')\rho})/(\mu_2' - \mu_2)$ where n_{02} is an electron density per

unit volume of the intermediate substance. The equation for determining σ_4 is

$$\sigma_4 = \frac{n_{04} \cdot \phi \cdot \sigma_2}{\mu_4}\left(1 - \frac{1}{\mu_4 l} + \frac{e^{-\mu_4 l}}{\mu_4 l}\right)$$

where n_{04} is an electron density per unit volume of the target, μ_4 is the absorption coefficient of the target for the original γ ray, and l is thickness of the target. (auth)

10078 FIELD-THEORY METHOD IN THE QUANTUM-MECHANICAL MANY-BODY PROBLEM. II. CONCEPT OF METHODS. Kisdi, David (Research Group for Theoretical Physics, Hungarian Academy of Sciences). ATOMKI (At. Kut. Intez.) Kozlem., 8: 159-88(June 1966). (In Hungarian).

The Goldstone and Hugenholtz formulas which make it possible to determine the ground-state energy and the amplitude of the state vector of real systems, together with the energy and state probability of quasi-holes, were derived by means of field-theory techniques. The value of the reaction operator R(z) becomes very important when an attempt is made to calculate the matrix elements related to the deviation from the ideal system in the case of the excitation of the ground state and the quasi-particle. In view of the fact that it is impossible to obtain an exact solution of the equations by the currently available computer techniques, approximation methods must be used. The errors involved in this approach were not estimated mathematically but were determined by comparing the values obtained with experimental data. The Rayleigh-Schroedinger, Bethe-Goldstone, Hugenholtz, and the Brueckner approximation methods were examined, the latter as corrected by Bethe; for Fermi liquid the Brueckner method was used. The applicability of a given method was examined for low- and high-density boundary conditions. (TTT)

10079 COMPUTATION OF SLOW NEUTRON DIFFERENTIAL SCATTERING CROSS SECTIONS BY TIME INTEGRATION. Turchin, V. F. J. Nucl. Energy: Pt. A and B, 20: 1019-25 (Nov.-Dec. 1966).

A method of calculating slow neutron bound atom differential scattering cross sections is proposed which involves integration of the van Hove formula into which a cut-off factor has been inserted under the integral sign. This procedure leads to an averaging of the cross sections over a certain energy interval and, in turn, it can be used in the comparison of theoretical with experimental data. The method enables one to calculate differential cross sections for liquids using the model previously proposed by the author. Calculations for water and for ice close to its melting point reveal the presence of a sudden jump in the total cross section during the transition from ice to water, in agreement with the experimental data of Heinloth. (auth)

10080 ALPHA DECAY ENERGY SYSTEMATICS AND α STABILITY OF NUCLEI. Kolesnikov, N. N.; Krylova, A. P. (Moscow State Univ.). Izv. Vyssh. Ucheb. Yaved., Fiz., No. 1, 183-6 (1966). (In Russian).

The alpha decay energy $E_\alpha(A,Z) = E_\alpha^*(A) + 4\kappa(1-2\eta)(Z-Z^*(A))$. Here E_α^* is the alpha decay energy of an isobar with $Z = Z^*(A)$, where Z^* is the value of a fictitious isobar whose mass attains a minimum value. The value of $E_\alpha(A,Z)$ does not depend on the oddness or evenness of a nucleus. Numerical values of the parameters κ and η are, respectively, 0.57 and 0.356 for $Z > 82$ and $N > 126$, 0.7 and 0.363 for $126 > N > 90$, 0.5 and 0.4125 for $N < 126$ and $Z > 82$, and 0.63 and 0.35 for $82 < N < 90$. The value of E_α can be calculated for any nucleus with an error of not more than ±0.3 MeV. As an example, the value of E_α is estimated to be 9.5 MeV for the nucleus 110^{277}. Its half life is estimated to be 1000 sec. Hence, spontaneous fission and not alpha decay may limit the existence of heavy nuclei. (TTT)

10081 SPECTRUM OF SCHROEDINGER'S OPERATOR USED IN THE OPTICAL MODEL OF THE NUCLEUS. Ramm, A. G. Dokl. Akad. Nauk SSSR, 169: 799-802(1966). (In Russian).

The Schroedinger equation describing nucleon scattering on nuclei, which is ordinarily limited to the case of a spherically symmetric potential, is reduced to a generalized case. (R.V.J.)

10082 PARTICLE-HOLE MODEL IN NUCLEAR PHYSICS. Boeker, E. (Oxford Univ.). Ned. Tijdschr. Natuur., 32: 285-321(Sept.-Oct. 1966). (In Dutch).

The shell model and the atomic nucleus and the concepts originating from it are described. The mathematical formalism of the particle-hole model is treated. The effects of the Gillet model are considered. Several nuclear reactions (photoemission and absorption, inelastic scattering of electrons, and inelastic scattering of protons and α particles) are discussed within the framework of the particle-hole model. (J.S.R.)

10083 POLARIZED TARGETS: WHY? AN ANSWER IN THE FRAMEWORK OF THE NONDYNAMICAL DESCRIPTION OF NUCLEAR REACTIONS. Fick, D. (Univ., Erlangen-Nuremberg). Phys. Lett., 24B: 13-14(Jan. 9, 1967).

In the framework of the nondynamical description, the nuclear reactions of spin type $1 + 1 \rightarrow 0 + 0$, $\frac{1}{2} + \frac{1}{2} \rightarrow 0 + 0$, $\frac{1}{2} + \frac{1}{2} \rightarrow \frac{1}{2} + \frac{1}{2}$, $1 + \frac{1}{2} \rightarrow 0 + \frac{1}{2}$, and $\frac{1}{2} + \frac{1}{2} \rightarrow 0 + 1$ are investigated. In the case of the first two reactions, a polarized target is needed in any case; for the last reaction no polarized target is necessary. In the case of the other two reactions, a polarized target may be useful. (auth)

10084 ENERGY DEPENDENCE OF AVERAGE DIRECT REACTION CROSS SECTIONS AND PARTIAL NUCLEAR LEVEL DENSITIES. Griffin, J. J. (Univ. of Maryland, College Park). Contract AT(40-1)-3491. Phys. Lett., 24B: 5-7(Jan. 9, 1967).

The possibility of studying partial level densities by measuring the energy dependence of average cross sections for direct reactions is pointed out. The (α,p) reaction is discussed, in particular; and a comparison of calculation and experiment is presented as an illustrative example. (auth)

10085 INFLUENCE OF THE MEAN FIELD ON THE CHARACTER OF VARIATION OF THE NUCLEAR SHAPE. Berlovich, E. E. (Ioffe Inst. of Physics and Tech., Leningrad). JETP Lett. (USSR) (Engl. Transl.), 4: 323-5(Dec. 1, 1966).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Redaktsiyu, 4: 481-4(Dec. 1, 1966).

Some characteristics of nuclear shape are qualitatively explained by starting from the properties of the levels of the self-consistent field. Various cases are considered, and it is stated in general that the character of the change of the nuclear shape is determined to a considerable degree by the properties of the levels of the mean field. (J.F.P.)

10086 MAGNETIC MOMENTS OF EVEN NUCLEI IN PHENOMENOLOGICAL MODELS OF COLLECTIVE QUADRUPOLE EXCITATIONS. Grechukhin, D. P. Yadern. Fiz., 4: 953-7(Nov. 1966). (In Russian).

A connection between the magnetic and quadrupole moments of excited states in even nuclei is established on the basis of the fundamental postulates of phenomenological models for nuclear collective quadrupole excitations. An experimental check of the obtained relation will make it possible to determine, how purely the collective variables are separated from the whole complex of nucleon coordinates, and to investigate the possibility of describing levels in even nuclei purely in terms of collective variables. The existing experimental data are briefly discussed. (auth)

10087 STRUCTURE OF ISOBARIC ANALOG STATES IN HEAVY NUCLEI. Zaretskii, D. F.; Urin, M. G. (Moscow Engineering-Physics Inst.). JETP Lett. (USSR) (Engl. Transl.), 4: 255-7(Nov. 1, 1966).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Redaktsiyu, 4: 379-81(Nov. 1, 1966).

It is shown that the energy of analog states and the excitation cross section in the simplest reactions, particularly the (p,n) reaction, can be determined by assuming that the analog states constitute, with respect to the target nucleus, collective excitations of the proton-neutron hole type. (D.C.W.)

10088 POSSIBLE ROLE OF ANN FORCES IN HYPERNUCLEI. Gal, A. (Weizmann Inst. of Science, Rehovoth, Israel). Phys. Rev., 152: 975-9(Dec. 16, 1966).

The effect of a repulsive three-body ΛNN force on the Λ-N scattering lengths and the ${}_\Lambda He^4 - {}_\Lambda H^4$ binding-energy difference is considered. It is found that a suitable three-body force strength needed to adjust the Λ-N scattering lengths to the measured Λ-p ones reduces substantially the additional Coulomb repulsion in ${}_\Lambda He^4$. Some remarks are made concerning the charge-symmetry-breaking components of the Λ-N interaction. (auth)

10089 DEUTERON OPTICAL-MODEL ANALYSIS WITH SPIN-ORBIT POTENTIAL. Perey, C. M.; Perey, F. G. (Oak Ridge National Lab., Tenn.). Phys. Rev., 152: 923-31(Dec. 16, 1966). (ORNL-P-2237).

An optical-model analysis of 19 deuteron elastic-scattering angular distributions in the energy range from 12 to 26 MeV was performed both with and without a spin-orbit term included in the potential. The spin-orbit potential was of the Thomas form which had been found satisfactory for fitting the measured deuteron elastic polarization. Including the spin-orbit term always resulted in an improvement in the quality of the fits. Without the spin-orbit term, various families of potentials fitted the data equally well, but when the spin-orbit potential was added the various families were no longer equivalent in many cases. The deuteron optical-model potential which most closely approximates the sum of the neutron and proton optical-model potentials was found to give the

most consistently satisfactory results for all the angular distributions. (auth)

10090 COMPACT-CLUSTER EXPANSION FOR THE NUCLEAR MANY-BODY PROBLEM. Brandow, Baird H. (NORDITA, Copenhagen). Phys. Rev., 152: 863-82(Dec. 16, 1966).

Bethe's treatment of three-body clusters is extended to the entire linked-cluster perturbation series. The result is a completely rearranged expansion in terms of "compact clusters." The spatial correlations within these terms are all of quite short range. As a direct consequence, each of these new compact-cluster terms is proportional to $\kappa^{h'-1}$, where h' is the number of momenta inside the Fermi sea which can be summed independently after allowing for momentum conservation. The "small parameter" of the expansion is $\kappa = \rho\int|\xi|^2 d\tau$, where ρ is the ordinary nuclear density and $\xi = \phi - \psi_{BC}$ is the "wound" in the correlated two-body (Bethe-Goldstone) wave function. In nuclear matter this κ is of order 10%. This result requires that the single-particle potentials be defined in terms of a certain subset of all the self-energy insertions. The allowed insertions are those which can be evaluated entirely on the energy shell, by means of a "generalized time-ordering" factorization. The totality of these insertions is said to constitute an "on-energy-shell mass operator" M^{on}. The resulting occupied-state potentials are quantitatively very similar to those of most previous versions of nuclear-matter theory. However, the present intermediate-state potentials are small enough (being only of order +1 MeV) to be safely ignored in practical calculations. This simplification is offset by the need for a separate calculation of the three-body clusters. These single-particle potentials are "physically meaningful" in the sense that they lead to an optimum treatment of the short-range correlations. The bulk properties of nuclear systems are determined almost entirely by these short-range correlations. It is therefore proposed that similar potentials be used in a many-body theory of finite nuclei. True occupation numbers occur in a simple and natural way throughout the entire expansion. The formal and practical consequences of this feature are carefully examined. It is argued that this is significant for a theory of finite nuclei. Comparisons are made with several different "renormalized" formulations of quantum statistical mechanics, and also with the Green's-function theory of nuclear matter. The present formulation tends to artificially suppress the long-range correlations (e.g., pairing correlations) between particles near the Fermi surface. This defect can be eliminated by using a degenerate analog of the Goldstone expansion. (auth)

10091 EXCITATION OF GENERALIZED GIANT COLLECTIVE MULTIPOLE STATES BY ELECTRON SCATTERING. Raphael, R. (Catholic Univ., Washington, D. C.); Ueberall, H.; Werntz, Carl. Phys. Rev., 152: 899-907(Dec. 16, 1966).

A collective model for finite nuclei is presented which treats all of the four types of excitations of nuclear matter in arbitrary orbital-angular-momentum states. The model avoids the normal assumption of a constant ground-state density by generating the collective motion through a coordinate-scale-factor transformation of the ground-state density distribution. The cross sections for excitation of these generalized collective states by inelastic electron scattering are calculated for monopole and quadrupole oscillations. A specific application to the 180° inelastic scattering of electrons from ^{16}O is given. It is shown that the model exhausts the corresponding multipole sum rules. (auth)

10092 THEORY OF COULOMB DISINTEGRATION OF COMPLEX NUCLEI. Nakamura, Kosuke (Univ. of California, San Diego, La Jolla). Phys. Rev., 152: 955-69(Dec. 16, 1966).

A general formulation of the Coulomb disintegration of complex nuclei is presented using the semiclassical approximation. This assumes that the center of gravity of the incident nucleus moves along a Rutherford orbit in the Coulomb field of the target nucleus. The main point of the formulation is the following: the configuration space of the product nuclei is divided into the external region and the internal region. In the external region, the wave function is assumed to be an outgoing free spherical wave. This wave function is then connected continuously to the internal wave function, which is taken, following the Kapur-Peierls method, to be a superposition of compound-state eigenfunctions of the incident nucleus. This method is applied to the Coulomb disintegration of ^{6}Li and is compared with the results which Gluckstern and Breit have already obtained. Some discussion about higher order corrections, which modify considerably the first-order perturbation calculation in the case of ^{6}Li, and about the stripping mechanism is added. (auth)

10093 TEST OF STATISTICAL THEORY OF NUCLEAR REACTIONS AT 24 keV. Chaubey, A. K.; Sehgal, M. L. (Aligarh Muslim Univ., India). Phys. Rev., 152: 1055-61(Dec. 16, 1966).

Neutron-activation cross sections were measured for about 40 nuclei. An Sb–Be photoneutron source was used for the measurements. The cross sections were measured to ^{127}I, whose cross section was taken equal to 0.82 b. With these measured values of the cross sections, calculations were made using the statistical theory of nuclear reactions, to obtain information about the parameter $\xi = D/2\pi\Gamma_\gamma$, where D is the average level spacing and Γ_γ is the radiation width. These values of ξ were compared with those obtained from low-energy resonance parameters. In general there is good agreement between the calculated and the observed values of ξ, which shows that the statistical theory is valid at this energy for all types of nuclei. It was also found that ξ is a smoothly varying function of the capture cross section σ. (auth)

10094 ACCOUNT OF HIGHER APPROXIMATIONS WITH RESPECT TO THE NONSPHERICITY PARAMETER IN THE THEORY OF INELASTIC DIFFRACTION SCATTERING. Inopin, E. V.; Shebeko, A. V. (Inst. of Physics and Tech., Academy of Sciences, Ukrainian SSR). Zh. Eksp. Teor. Fiz., 51: 1761-70 (Dec. 1966). (In Russian).

Formulas for the cross sections of inelastic scattering with excitation of collective nuclear levels are derived by the method of approximate separation of variables. Expansion into a series in the nonsphericity parameter is not employed in the calculations and hence the effect of higher approximations in this parameter can be studied. It is shown that in the case of vibrational levels account of higher approximations leads merely to simple renormalization of the initial elastic scattering S-matrix. In the case of rotational levels account of higher approximations leads to deviation from the Blair phase rule. The sign of nuclear deformation can be determined by observing the deviations. (auth)

10095 ANGULAR MOMENTUM EFFECTS IN THE COMPOUND-STATISTICAL MODEL FOR NUCLEAR REACTIONS. II. THE IMPORTANCE OF THE FERMI GAS MODEL PARAMETERS ON CALCULATED EXCITATION FUNCTIONS. Sarantites, Demetrios G. (Washington Univ., St. Louis). Contracts AT(11-1)-1162; AT(11-1)-1530. Nucl. Phys., A93: 567-75(1967). (COO-1530-4).

The Monte Carlo technique was employed in calculations of excitation functions in the framework of the evaporation model with detailed dependence of the emission probability on angular momentum. Comparison of calculated excitation functions in the ^{107}Ag + ^{4}He ion system with experiment is made. The dependence of the calculated excitation functions on the Fermi gas model parameters for the level density expression is discussed. The effect of gamma competition for de-excitation on the calculated excitation functions is examined. Values of the level density parameter a in the range $\approx A/12.5$ to $1/15A$ and of moments of inertia of the rigid body provide satisfactory agreement with experiment. A significant fraction of de-excitation by gamma emission needs to be assumed in order to obtain better agreement with experiment. (auth)

10096 EFFECT OF GAMMA-RAY COMPETITION IN STATISTICAL-MODEL CALCULATIONS OF ISOMER YIELD RATIOS. Sarantites, Demetrios G. (Washington Univ., St. Louis). Contracts AT(11-1)-1162; AT(11-1)-1530. Nucl. Phys., A93: 576-96 (1967).

The distributions in angular momentum in the formation of compound nuclei in ^{4}He ion bombardments and in their de-excitation by particle or gamma emission were investigated in a compound-statistical model calculation of excitation functions and particle evaporation spectra. The calculation was performed by the Monte Carlo technique, and from the distributions in angular momentum in the reaction products, isomer yield ratios were calculated and were compared with experiment. The importance of gamma emission in competition with particle evaporation is discussed in detail. It is shown that the effect of the preferred population of the higher angular momentum states in the (α,n) reaction product over that for the $(\alpha,2n)$, termed "spin fractionation," depends critically on the strength of the gamma competition. Agreement with experimental isomer ratios is obtained with model parameters which are consistent with the predictions of the Fermi gas model and which give agreement between calculated and experimental excitation functions. (auth)

10097 UPPER AND LOWER BOUNDS OF THE EIGENVALUE OF A FOUR-BODY SYSTEM. Tang, Y. C. (Univ. of Minnesota, Minneapolis); Herndon, R. C. Nucl. Phys., A93: 692-8(1967).

The upper and lower bounds of the ground-state eigenvalue of a four-body system are determined. The two-body nuclear potential employed is a simple Gaussian potential which was used by a number of authors in their calculations on a three-body system. With a four-parameter trial function, the two bounds are calculated to be -38.98 ± 0.08 and -39.52 ± 0.19 MeV, respectively. Using these values, it is estimated that the eigenvalue of this particular four-body system is -39.1 ± 0.1 MeV. (auth)

10098 MODIFIED TWO-BODY INTERACTION. Antone, T. A. (Univ. of Southhampton, Eng.). Nucl. Phys., A93: 699-704(1967).

The Bryan and Scott spin-orbit force is shown to have anti-Serber charge dependence. This spin-orbit force with a Gartenhaus radial dependence is combined with the two-body, central-tensor interaction introduced by Goldhammer to form a modified two-body interaction. This interaction gives the correct doublet splitting and appreciable binding energy for ^{5}He. (auth)

10099 ONE-LEVEL APPROXIMATION AND ISOSPIN PURITY AT THE ISOBARIC ANALOGUE RESONANCES. Mahaux, C. (Univ. of Liege. Univ., Heidelberg); Wiedner, C. A. Nucl. Phys., A93: 327-39(1967).

Lane's coupled equations describing the doorway-state wave function of an isobaric analogue resonance are solved for square-well potentials. The dependence of the isospin purity of the s-wave scattering function in the interaction region on the energy of the incoming proton and the strength of the coupling potential is investigated. The variation of the total and partial widths and of the resonance energy with the strength of the complex coupling potential is given and is compared with theoretical expressions. The smallness of the amplitude of the isospin impurity supports the assumptions made in Weidenmüller's schematic theory. (auth)

10100 ANGULAR MOMENTUM EFFECTS IN THE COMPOUND-STATISTICAL MODEL FOR NUCLEAR REACTIONS. I. MONTE CARLO CALCULATIONS OF EXCITATION FUNCTIONS. Sarantites, D. G.; Pate, B. D. (Washington Univ., St. Louis). Contracts AT(11-1)-1162; AT(11-1)-1530. Nucl. Phys., A93: 545-66(1967). (COO-1530-3).

The evaporation formalism of the compound-statistical theory of nuclear reactions is presented in a form containing the explicit dependence of the emission probability on angular momentum and suitable for computation of excitation functions by the Monte Carlo technique. The dependence of the nuclear level density on angular momentum is discussed, and an improved expression is offered. Monte Carlo calculations led to the evaluation of excitation functions in selected reactions, and the results were compared with experiment. The effect of competing de-excitation by gamma emission is examined, and its magnitude is estimated from an analysis of excitation-function data. Satisfactory agreement between calculated and experimental excitation functions induced by ^{4}He ions of kinetic energy up to 40 MeV is obtained using the Fermi gas model parameters for the level density expression. (auth)

10101 PARITY MIXING IN NUCLEAR HARTREE–FOCK CALCULATIONS. Bassichis, W. H.; Svenne, J. P. (Massachusetts Inst. of Tech., Cambridge). Phys. Rev. Lett., 18: 80-2(Jan. 16, 1967).

A simplified force consisting of the central and tensor parts of the Hamada-Johnston force with the infinite hard cores replaced by finite cores was constructed and was used to investigate parity mixing. The closed-shell nuclei ^{40}Ca, ^{4}He, and ^{16}O and the deformed nuclei ^{8}Be, ^{12}C, ^{20}Ne, and ^{28}Si were considered. (D.C.W.)

10102 EQUILIBRIUM DEFORMATIONS CALCULATED WITH PROJECTED WAVE FUNCTIONS FOR RARE-EARTH NUCLEI. Sobiczewski, A. (Joint Inst. for Nuclear Research, Dubna, USSR). Nucl. Phys., A93: 501-12(1967).

The ground-state equilibrium deformation and the deformation energy are calculated for even nuclei in the rare-earth region. The method of calculation is the same as that of Bès and Szymański, but the projected wave functions (PBCS) corresponding to a definite number of particles is used, instead of the BCS wave function. It is shown that although the value of the ground-state energy is lowered by a few MeV in comparison with the BCS case, the dependence of the energy on the deformation and hence the equilibrium deformations are not changed much. The role of the Coulomb term in the formula for the energy is discussed. (auth)

10103 LONG-RANGE PART OF THE TWO-NUCLEON INTERACTION AND THE PROPERTIES OF NUCLEAR MATTER. Razavy, M.; Chiang, C. C. (Univ. of Alberta, Edmonton). Nucl. Phys., A93: 513-21(1967).

The separation method is applied to the calculation of the rearrangement energy, the symmetry energy, and the compressibility of the nuclear matter. The cut-off distance and its derivatives with respect to the density are determined from the values of the binding energy and the equilibrium density of the many-nucleon system. The rearrangement energy and the compressibility for the Brueckner-Gammel-Thaler potential are found to be 11.7 and 239 MeV, respectively. For the same potential, using the free-particle reaction matrix in the singlet-even and the triplet-odd states, the value obtained for the symmetry energy is about 22 MeV. (auth)

10104 DISTRIBUTION OF THE TOTAL WIDTH. Ullah, Nazakat (Tata Inst. of Fundamental Research, Bombay). Nucl. Phys., A93: 522-6(1967).

A formulation of the statistical distribution of the total width is presented starting from the exact multichannel distribution of the reduced-width amplitudes. The results previously obtained by Porter and Thomas and by Wilets are shown to be special cases of the present formulation. A closed form expression for the distribution of the dimensionless width in the case of two channels is given. This correct distribution is compared with the best fitting χ^2-distribution. A model is presented which brings out the effects of channel correlations in a simple way. (auth)

10105 INFLUENCE OF NUCLEAR STRUCTURE ON BINDING ENERGY. Kravtsov, V. A.; Skachkov, N. N. (Kalinin Polytechnic Inst., Leningrad). Nucl. Data, Sect. A, 1: 491-519(Aug. 1966).

Graphs are presented of the intersections of nuclear binding energy surfaces by planes I = N − Z = constant. Ridges and valleys on the energy surface are shown; the valleys are related to shells while the ridges act mostly as boundaries of regions of deformed nuclei. The sharpness, D(Z,N), of discontinuities, valleys and ridges, is considered and is proposed as a new energy characteristic of nuclear shells. Graphs are presented showing the dependence of sharpness on the number of nucleons. In order of decreasing sharpness the shells identified are: 8p, 8n, 126n, 82p, 50n, 82n, 50p, 28p, 28n, 14p, 14n, 40p, 20n, 70p, 20p, 152n, and 66p. Weak ridges are associated with 4p, 10p and with 4n, 10n, 22n, 88n, and 114n. The dependence of the separation energy of neutron pairs, S_{2n}, on the number of protons and of the separation energy of proton pairs, S_{2p}, on the number of neutrons is presented on other graphs which are analyzed from the viewpoint of nuclear structure. All the graphs were prepared on the basis of the 1964 nuclidic masses [J. Mattauch, Nucl. Phys. 67: 1 and 32(1965)]. (auth)

10106 DIFFRACTION THEORY OF QUASI-ELASTIC INTERACTIONS. Abul-Magd, Adel Y. (Atomic Energy Establishment, Cairo). Nucl. Phys., A93: 321-6(1967).

The cross section for a quasi-elastic process is calculated from the expression of the elastic scattering amplitude obtained in diffraction theory. The radius of the nuclear interaction is assumed to depend linearly on the isospins of the interacting nuclei. The comparison between the predicted quasi-elastic angular distribution and the parent elastic distribution shows that the decay of the pattern of the latter is sharper than that of the former and that both patterns oscillate with the same period but in opposite phases. The angular distribution obtained in the quasi-elastic case is in satisfactory agreement with the experimental data. The effect of the presence of an open quasi-elastic channel on the elastic scattering cross section is investigated; it is found to be small especially in the forward scattering hemisphere. (auth)

10107 ELASTIC NEUTRON–DEUTERON SCATTERING WITH POLARIZED PARTICLES. Kharchenko, V. F.; Petrov, N. M. (Inst. of Physics, Kiev). Nucl. Phys., A93: 289-99(1967).

Polarization phenomena in the elastic neutron-deuteron scattering resulting from the spin-spin interaction between nucleons are considered. Numerical results are obtained on the basis of the exact solution of the three-nucleon problem for the case in which the interaction between nucleons is described by a non-local separable potential. The results favor the phase shifts of Christian and Gammel. (auth)

10108 TWO-PARTICLE GREEN FUNCTIONS AND NUCLEAR STRUCTURE. Mulhall, W. J. (Centro Atomico Bariloche, Argentina. Instituto de Fisica, Bariloche, Argentina); Liotta, R. J.; Evans, J. A.; Perazzo, R. P. J. Nucl. Phys., A93: 261-71(1967).

The two-particle Green function is studied in terms of the ladder approximation and is applied to the two-particle shell model. The resulting non-Hermitian eigenvalue problem is solved in a simple schematic model, and conclusions are drawn regarding electromagnetic transition probabilities and the cross sections for two-particle transfer reactions. (auth)

10109 COHERENT PAIRING FLUCTUATIONS AND COLLECTIVE 0^+-EXCITATIONS OF NUCLEI. Belyaev, S. T. Yadern. Fiz., 4: 936-52(Nov. 1966). (In Russian).

The collective 0^+ excitations in nuclei, connected with the interaction in the particle-particle channel, were investigated in the framework of the self-consistent time-dependent field method. Two classes of excitations with different time parities were found, both being coherent pairing fluctuations. The T-even branch (predicted earlier by Bohr and Mottelson) is characterized by weak E0-transitions to the ground state whereas the T-odd branch has a large E0-transition probability. The excitation cross sections in the (t,p)-reaction are considered and they prove to be of the same order of magnitude for both types of branches. (auth)

10110 ELECTRIC TRANSITIONS IN SPHERICAL NUCLEI. Bunatyan, G. G. (Moscow Inst. of Physics and Engineering). Yadern. Fiz., 4: 920-7(Nov. 1966). (In Russian).

The theory of finite Fermi systems is applied to investigate the giant E1, E2, and E0 resonances in spherical nuclei. (auth)

10111 PARTICLE-HOLE EXCITATION AND IMPURITY OF ISOBARIC SPIN. Yoccoz, J.; Jang, S. (Centre de Recherches Nucleaires, Strasbourg. Institut de Recherches Nucleaires, Strasbourg). Nucl. Phys., A92: 505-12(1967). (In French).

The Coulomb force in particle-hole excitation is examined by introducing explicit hole states by a canonical transformation. The calculated Coulomb energies are exploited in the study of isospin impurities of certain excited states in self-conjugate nuclei; in particular the giant dipole states of ^{16}O are investigated. (auth)

10112 DYNAMIC COLLECTIVE THEORY OF THE QUADRUPOLE GIANT RESONANCE IN DEFORMED NUCLEI. Ligensa, Rainer; Greiner, Walter (Univ., Frankfurt am Main). Nucl. Phys., A92: 673-95(1967).

The theory of photon excitation was extended into the region immediately above the giant dipole resonance. This was accomplished by use of the hydrodynamical model. The dynamic coupling of the giant quadrupole oscillations with surface vibrations, rotational modes, and single-particle motions were taken into account. The quadrupole operator was computed, the resulting energy spectrum, transition probabilities, and E2 absorption cross sections were derived. Finally the calculations were compared with experimental data. Recent Livermore experiments seem to give evidence for the existence of giant quadrupole resonances. (auth)

10113 COLLECTIVE POTENTIAL ENERGY AND SHAPE FLUCTUATIONS OF EVEN NUCLEI. I. DYNAMICAL EFFECTS IN ^{154}Sm. Kumar, Krishna (Univ. of California, Berkeley. Michigan State Univ., East Lansing). Nucl. Phys., A92: 653-72 (1967).

Collective quadrupole motion of even nuclei, described by Bohr's Hamiltonian, is investigated by using the numerical method of Kumar and Baranger. A potential function, which is an extension of the Myers-Swiatecki potential, is suggested. Parameters of the Hamiltonian are determined by fitting the experimental data. Effects of dynamics or quantal fluctuations of the nuclear shape are appreciable in ^{154}Sm, a well-deformed nucleus, and cause coupling between β-vibrations, γ-vibrations and rotations. A new type of band, which represents a strong mixing of prolate, spherical, and oblate shapes, is predicted. (auth)

10114 COMPLETE NUMERICAL SOLUTION OF BOHR'S COLLECTIVE HAMILTONIAN. Kumar, Krishna (Michigan State Univ., East Lansing); Baranger, Michel. Nucl. Phys., A92: 608-52(1967).

The general form of Bohr's collective Hamiltonian for quadrupole deformations is reviewed. It contains seven largely arbitrary functions of β and γ, the potential energy and six inertial functions. A thorough discussion is given of the symmetries of these seven functions and of the corresponding properties of the solutions of the Schrödinger equation. A purely numerical method involving a finite mesh is developed for solving this Schrödinger equation. The output of the calculation consists in the low-lying levels, the corresponding wave functions and the relevant E2 and M1 static and transition moments; the latter depend on the intrinsic quadrupole moments and intrinsic gyromagnetic ratios as functions of β and γ. The numerical method is tested on a number of examples and is found to be sufficiently accurate for application to spherical, transition and many deformed nuclei. (auth)

10115 STRUCTURE OF FINITE NUCLEI AND THE FREE NUCLEON–NUCLEON INTERACTION. GENERAL DISCUSSION OF THE EFFECTIVE FORCE. Brown, G. E.; Kuo, T. T. S. (Princeton Univ., N. J.). Nucl. Phys., A92: 481-94(1967). (PUC-937-216).

It is shown that the main features of the observed effective forces in nuclei can be calculated directly from the free nucleon-nucleon interaction. Although the unrenormalized interaction acts as a short-range force, the renormalized one contains P_2, P_4 and other multipole forces. The calculated strength of the P_2 force agrees well with that obtained empirically. (auth)

10116 ON THE BIREFRINGENCE OF γ-QUANTA IN A POLARIZED NUCLEAR TARGET. Baryshevskii, V. G. (Belorussian State Univ., USSR). Yadern. Fiz., 4: 1045-7(Nov. 1966). (In Russian).

The penetration of a linearly polarized beam of γ quanta through a target with nonzero nuclear quadrupolarization is considered. It is shown that such a target gives rise to the birefringence of the γ quanta, in analogy to the birefringence of light passing through a uniaxial or biaxial crystal. (auth)

10117 ON THE NEUTRON EMISSION ASYMMETRY IN μ-CAPTURE. Zelevinskii, V. G. (Inst. of Physics, Academy of Sciences, Siberian SSR). Yadern. Fiz., 4: 1021-30(Nov. 1965). (In Russian).

A large asymmetry in the angular distribution of neutrons is observed experimentally in the absorption of polarized muons by nuclei. The possible upper limit of this effect is estimated for the usual one-nucleon capture mechanism, assuming the process to be described by the nonrelativistic Primakoff Hamiltonian. It is shown that under these conditions kinematic relations exist between the matrix elements, in view of which no internuclear correlations of the emitted neutron can lead to asymmetries, significantly larger than those in the capture by a free proton (the magnitude of the spin-orbital coupling is estimated according to the optical model). Other possible explanations of the experiments are briefly discussed. (auth)

10118 ON THE THEORY OF DIRECT REACTIONS. II. Buck, B.; Rook, J. R. (Nuclear Physics Lab., Oxford). Nucl. Phys., A92: 513-38(1967).

Distorted-wave theories for a direct reaction amplitude M_{12} connecting channels 1 and 2 are usually obtained from the formal theory of scattering by means of a long chain of approximations. A version of distorted wave theory is considered which involves just one basic assumption and which can be further approximated to yield all the currently used expressions. It is shown that this basic assumption, which underlies all the usual theories, leads plausibly to the relation $\mathrm{Im}\, M_{12} = M_{12} f_{11}^{\dagger} + M_{12}^{\dagger} f_{22}$, where f_{22} and f_{11} are the elastic scattering amplitudes in the initial and final channels. The result is discussed by means of a simple model of nuclear reactions and also on the basis of a more general theory. The implications of this "truncated unitarity relation" were brought out in an earlier paper, where it was shown to give very stringent conditions for the validity of the distorted wave treatment. (auth)

10119 OPTICAL MODEL ANALYSIS OF THE ELASTIC SCATTERING OF 27.2-MeV α PARTICLES ON ^{27}Al AND ^{12}C NUCLEI. Nemets, O. F.; Rudchik, A. T. (Inst. of Physics, Academy of Sciences, Ukrainian SSR). Yadern. Fiz., 4: 970-4(Nov. 1966). (In Russian).

The applicability of various imaginary parts of the optical model potential is investigated to describe the angular distributions of elastically scattered 27.2-MeV α particles on ^{27}Al and ^{12}C. It is found that a reasonable description of the experimental data is obtained both for an optical potential with a volume type imaginary part and for one with its imaginary part localized on the nuclear surface. The discrete ambiguities of the Woods–Saxon optical model parameters are investigated for the elastic scattering on the ^{27}Al nucleus. (auth)

10120 NONORTHOGONALITY OF THE WAVE FUNCTIONS IN THE UNIFIED THEORY OF NUCLEAR RESONANCE REACTIONS. Gordeev, I. V. Yadern. Fiz., 4: 958-61(Nov. 1966). (In Russian).

The theory of resonance nuclear reactions using the approximate orthogonality of the wave functions for the compound nucleus and for the open reaction channels is generalized to the case when the nonorthogonality of the wave functions in two subspaces is taken into account. Although the form of the S-matrix does not change, the expression for the transition operator and the reduced neutron half widths is modified. Corrections for the nonorthogonality of the wave functions are taken into account in the expression for the partial widths. (auth)

10121 DEVELOPMENT OF THE MECHANISM DETERMINED BY POLE AND FOUR-POINT DIAGRAMS IN DIRECT (t,p) AND (^{3}He,p) REACTIONS ON 1p-SHELL NUCLEI. Pang, Yens; Zelenskaya, N. S.; Magzumov, E. Zh.; Neudachin, V. G. (Moscow State Univ.). Yadern. Fiz., 4: 962-9(Nov. 1966). (In Russian).

It is shown that the direct (t,p) and (^{3}He,p) reactions on p-shell nuclei cannot be universally described by a single simplest diagram. It is suggested that the difference in binding energies ($\Delta E = E_1 - E_2$) of the two captured protons should be used as a physical criterion for the choice of the diagram. In the case of large ΔE the four-point diagram should be expected to predominate (successive independent capture of the two nucleons). For small ΔE the interactions of the two captured nucleons is essential and the capture of a two-nucleon association (a deuteron or a bineutron in the 1s-state) will play a predominant role (a pole diagram). The analysis of the experimental data gives a good agreement with this picture. At $\Delta E_{max} \leq 10$ to 15 MeV the pole is realized and at $\Delta E_{max} > 30$ MeV (the center of the p-shell) – the four-point diagram. The possible realization of four-point diagrams in other nuclear reactions is discussed. (auth)

10122 DIRECTORY TO TABLES AND REVIEWS OF ANGULAR-MOMENTUM AND ANGULAR-CORRELATION COEFFICIENTS. Way, K.; Hurley, F. W. (Oak Ridge National Lab., Tenn.). Nucl. Data, Sect. A, 1: 473-86(July 1966).

Brief descriptions of comprehensive tables of Clebsch-Gordan, Racah, Wigner, and related coefficients and tables of coefficients of Legendre polynomials in angular-distribution expressions are

presented. These tables, which cover material available up to June 1966, supersede those in Section 3 of the 1958 Directory to Nuclear Data Tabulations and its supplements. Bibliographies of some abridged tables and review articles in the same field are included. (S.F.L.)

10123 CLEBSCH–GORDAN COEFFICIENTS FOR NUCLEAR TRANSITION PROBABILITIES FOR EVEN-A DEFORMED NUCLEI. Yamazaki, T. (Univ. of California, Berkeley). Nucl. Data, Sect. A, 1: 453-71(July 1966). (UCRL-16784).

A table was prepared in order to help calculate alpha-, beta-, and gamma-ray transition probabilities for deformed nuclei. A similar table for odd-mass deformed nuclei was issued before by Lum, Light, and Asaro (UCRL-9679). In addition to the Clebsch-Gordan coefficients, the squares of the coefficients are also tabulated, since the transition probabilities are proportional to the squares. The values were computed with an IBM-7094. (auth)

10124 INVESTIGATIONS IN THE THREE-BODY SYSTEM. Yam, Ying-Yeung. Philadelphia, Univ. of Pennsylvania, 1965. 128p.

Thesis.

Some recently developed formalisms are applied to the three-body problem. These formalisms give an exact account of the contributions to the three-body system from any set of two-body forces which one may assume. In this work, s-wave separable potentials are assumed and are parametrized with simple analytic forms. Exact numerical solutions to the three-body problem are then obtained. The effect of the two-body force on the three-body system is first studied for spinless particles, bound-state energies, scattering phase-shifts, angular distributions, and cross sections. It is seen that the response of the three-body system is as expected. A more realistic system, the three-nucleon system, is next studied. Spin and isospin of the nucleons are taken into account, but no tensor forces and hard cores are assumed. The two-body forces are fitted to the low-energy two-nucleon data. A quantitatively satisfactory account of both bound and scattering data of the neutron-deuteron system is provided by the theory. Some interesting structures, such as diffraction peaks, are also predicted. (Dissertation Abstr.)

10125 LES MECANISMES DES REACTIONS NUCLEAIRES. VI COURS DE PERFECTIONNEMENT DE L'ASSOCIATION VAUDOISE DES CHERCHEURS EN PHYSIQUE, GRAECHEN/SAINT-NICOLAS, 6–11 APRIL 1964. (Mechanisms of Nuclear Reactions. Sixth Improvement Course of the Vaud Association for Research in Physics, Graechen/Saint-Nicolas, 6–11 April, 1964). Lausanne, Switzerland, Bureau d'Impression, 1964. 351p.

Papers (6) dealing with the compound nucleus, the optical model of elastic scattering and direct reactions, the interpretation of angular distributions and correlations, Coulomb excitation, resonance reactions, and direct reactions are included. (D.C.W.)

10126 INTRODUCTION TO NUCLEAR PHYSICS. Enge, Harald A. Addison-Wesley Series in Physics. Reading, Mass., Addison-Wesley Publishing Co., Inc., 1966. 592p. $12.75.

Two-body problems, properties of stable nuclei, nuclear models, disintegration of unstable nuclei, nuclear reactions, nuclear power, and elementary particles are treated. The theories are discussed in relation to experimental observations. (D.C.W.)

REACTOR TECHNOLOGY

Central Power Reactors

Refer also to abstracts 8495, 8504, 8621, 9220, 9923, and 9924.

10127 (EUR–3079.e) EURATOM ECONOMIC HANDBOOK. Willems, M.; Huber, H.; Al, A.; Barazzoni, L. (European Atomic Energy Community). June 8, 1966. 67p. Dep. mn.

A study was made in order to gather all basic economic data relevant to the calculation of the nuclear power generating cost, taking into account the existing conditions in each of the Member States and in the Community as a whole. The objective was to propose a uniform method of nuclear power generating cost. This method for calculating nuclear power cost is presented as a method that can be applied whenever the need is felt to produce figures on the cost of the nuclear kWh which lend themselves to unequivocal interpretation. A practical application of the method is given. (D.L.C.)

10128 (GA–7426) 40-Mw(e) PROTOTYPE HIGH-TEMPERATURE GAS-COOLED REACTOR POSTCONSTRUCTION RESEARCH AND DEVELOPMENT PROGRAM. Quarterly Progress Report No. 9 for the Period Ending July 31, 1966. (General Dynamics Corp., San Diego, Calif. General Atomic Div.). Oct. 15, 1966. Contract AT(04-3)-314. 44p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The analyses of the measurements on loading and zero-power experiments were completed. Two data reduction codes used in the analyses are described along with post-experiment theoretical calculations. The experiments to be run during approach to power and at power are described. Test procedures for all remaining phases are summarized. (D.L.C.)

10129 (GEAP–5297) THE FUNCTIONS AND PERFORMANCE OF THE CONSUMERS BIG ROCK POINT PROCESS COMPUTER SYSTEM. Holladay, R. L. (General Electric Co., San Jose, Calif. Atomic Power Equipment Dept.). Oct. 1966. Contract AT(04-3)-361. 108p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

A description is given of the on-line computer system which has been developed for and installed in the Consumers Power Company Big Rock Point nuclear power plant in Charlevoix, Michigan. The development and performance of the computer and computer program up to the present time are discussed. The system description covers the computer hardware, sensor inputs, calculational programs, and system output. This latter item includes a description of the data logs available from the system. Finally, derivation and description are given of the thermal–hydraulic functions utilized by the computer programs. (D.L.C.)

10130 (HPR–69) HBWR QUARTERLY PROGRESS REPORT, JULY TO SEPTEMBER 1966. (Institutt for Atomenergi, Halden (Norway). OECD Halden Reaktor Prosjekt). Nov. 1966. 102p. Dep. mn.

A brief chronology of events in the Halden BWR is given, and the operations are described (statistics, test element failures, fission gas collection system, core transients, ventilation system). Research activities reported included activation, dynamics, and water chemistry, while development work covered fuel irradiation test, burnout detectors, and differential transformer. (D.L.C.)

10131 (UNC–5160) CARBON METER FOR SODIUM. Progress Report, February 21–June 30, 1966. (United Nuclear Corp., Elmsford, N. Y.). July 31, 1966. Contract AT(30-1)-3665. 40p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Development of a probe for continuous measurement of C activity in Na is described. The probe is to be a thin-walled tube, probably Fe or Ni, immersed in the Na and carrying a controlled flow of decarburizing gas. The C flux diffusing through the tube wall, as measured by a gas analyzer, is intended to serve as a measure of the C activity in the Na. A program plan for development of a complete instrument ready for field tests in less than two years is described. A preliminary design study is reported. A test rig for measuring C flux as a function of the major variables is nearing completion. (auth)

10132 (WAPD-TM–641) TEST OF THE TIME SYNTHESIS APPROACH FOR THE SOLUTION OF REACTOR KINETICS PROBLEMS. Bewick, J. A.; Kaplan, S. (Bettis Atomic Power Lab., Pittsburgh, Pa.). Oct. 1966. Contract AT(11-1)-Gen-14. 33p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

A series of numerical experiments are reported in which time dependent diffusion problems are solved approximately by various versions of the modal analysis and time synthesis methods. (auth)

10133 (EURFNR–102F) THE CONTROL OF THE FAST BREEDER RAPSODIE. Uberschlag, J.; Chapelot, A.; Lelait, R.; Abdon, R.; Jeannot, A.; Ladet, J. (Commissariat a l'Energie Atomique, Cadarache (France). Centre d'Etudes Nucleaires). Translation of report EUR–2145.f. 28p. Dep. mn. JCL $2.60 fs, $1.04 mf.

A brief introduction on the interest and some features of fast-breeder reactors is given. Some considerations are outlined, such as organization of the controls operation of the plant data-logging equipment. Some relatively well-defined control circuits are described. (auth)

10134 USE OF CONCRETE FOR SHIELDING HIGH-TEMPERATURE REACTORS. Dubrovskii, V. B.; Krasnoyarov, N. V.; Kulakovskii, M. Ya.; Pergamenshchik, B. K.; Pinkhasik, M. S.; Savitskii, V. A. J. Nucl. Energy: Pt. A and B, 20: 1031-8 (Nov.-Dec. 1966).

The possibility is examined of constructing thermal shields of reactors from chromite and fireclay heat-resistant concretes. Neutron fluxes of different intensities (up to 10^{13} n/cm^2 sec, close in spectrum to the fission–spectrum) absorbed by shields of these materials are examined. The passage of neutrons, γ-ray fluxes and generation of heat in the shield are taken into account. The temperatures in the shield are calculated for different neutron fluxes, thicknesses of concrete and cooling conditions. A static calculation of the temperature stresses in a shield constructed from heat-proof reinforced concrete is carried out. It is established that heat-resistant reinforced concrete can be used for the shields of nuclear reactors for neutron fluxes to the concrete up to 10^{13} n/cm^2 sec, temperatures up to 1100°C and temperature drops of up to 900°C. (tr-auth)

10135 ATTENUATION OF REACTOR RADIATIONS IN SERPENTINE SAND. Vasilev, G. A.; Veselkin, A. P.; Egorov, Yu. A.; Moiseev, G. G.; Pankratev, Yu. V. J. Nucl. Energy: Pt. A and B, 20: 1001-9(Nov.-Dec. 1966).

An experimental investigation of the attenuation of reactor radiations in serpentine sand having a poured density of 1.62 g/cm^3 is described. The sand examined contained about 11.5 per cent water in chemical combination, which is given off at temperatures above 450°C. Measurements were made of the attenuation of fast and thermal neutron fluxes, attenuation of the neutron dose and γ-radiation, and also of fast neutron spectra in serpentine sand. Relaxation lengths of fast neutrons calculated on the basis of the experimental data are compared with the relaxation lengths of fast neutrons in boron carbide, serpentine concrete and iron-ore concentrate. (tr-auth)

10136 DOSE-RATE FIELD OF AN IRRADIATOR WITH USED FUEL ELEMENTS AS THE SOURCE OF GAMMA RADIATION. Drozdov, V. E.; Zakharova, I. M.; Dobrovolskii, S. P. J. Nucl. Energy: Pt. A and B. 20: 1011-18(Nov.-Dec. 1966).

Experiments were carried out on the RFT reactor to determine the activity distribution along a fuel element. It was shown that the distribution of activity is satisfactorily described by a cosine function, and that the equations used to calculate the dose-rate field for irradiators with an even distribution of activity along the radiation source are inapplicable when such sources are fuel elements [the discrepancy is 23% for RFT and 32% for the First Atomic Power Station (AES)]. Good agreement was obtained between calculations and the experimental data. (tr-auth)

10137 EFFECT OF A BLACK SPHERE ON THE FLUX DISTRIBUTION IN AN INFINITE MODERATOR. Sahni, D. C. (Atomic Energy Establishment, Trombay, India). J. Nucl. Energy: Pt. A and B, 20: 915-20(Nov.-Dec. 1966).

The method of singular integral equations has been applied to obtain the monoenergetic flux distribution due to a black sphere in an infinite, absorption-free and isotropically scattering moderator. The linear extrapolation distances have been obtained from these calculations and compared with the variational calculations. (auth)

10138 USE OF FUSED SALTS FOR THE THERMOSTATIC CONTROL OF HIGH TEMPERATURE REACTORS. Fontana, L.; Pinacci, P. Termotecnica (Milan), 20: 609-16(Oct. 1966). (In Italian).

The composition and properties of HTS (a mixture of $NaNO_2$, $NaNO_3$, and HNO_3) are reported. The principal characteristics of plants using thermostatic control with fused salts are outlined. The design of such an installation is given. (J.S.R.)

10139 ON THE PRINCIPAL DETERMINATION OF THE OPTIMUM PARAMETERS OF NUCLEAR POWER PLANT COOLING SYSTEMS. Fratzscher, W.; Stephan, H. (Technical Univ., Dresden). Kernenergie, 9: 315-19(Oct. 1966). (In German).

The optimum thermodynamic and economic parameters of nuclear power plant cooling systems are discussed using simplifying presumptions. The optimum economic parameters essential for the definitive design of nuclear power plants were in good agreement with the thermodynamic results only in the extreme cases of theory. In general, they differ from each other and the difference is determined by the ratio of the yearly fixed cost to fuel cost. The calculations were made by using dimensionless equations. (auth)

10140 EXPERIENCE IN OPERATING THE SM-2 EXPERIMENTAL REACTOR. Tsykanov, A. V.; Averyanov, P. G.; Zverev, V. A.; Kusovnikov, A. S.; Kormushkin, Yu. P.; Samsonov, B. V.; Frunze, V. V.; Zaletnykh, B. A. Kernenergie, 9: 310-15 (Oct. 1966). (In Russian).

The operating experience of the SM-2 reactor showed that the main characteristics of the reactor determined during design were correct although the compensating power of both control and shielding system and the core height must be increased to realize the burn-up possible from the fuel element point of view and because of the necessary duration of continuous operation. The changes made after putting the reactor into operation improved its physical and economic parameters and the reliability of all the auxiliary devices. The high resistance to radiation of the structural materials used is stated. Experience is discussed concerning the operation of the reactor using special features. (auth)

10141 THE 50-Mw NUCLEAR POWER PLANT AT DODEWAARD. Mostert, P. (Gemeenschappelijke Kernenergiecentrale Nederland). Ned. Tijdschr. Natuur., 32: 211-20(July 1966). (In Dutch).

The Dodewaard nuclear power plant is supplied by a boiling water reactor with Zircaloy-clad UO_2 fuel elements. The characteristics of the reactor with emphasis on the primary circuits, reactor core, reactor vessel, pressure system, and instrumentation are described. (J.S.R.)

10142 TOKAI REACTOR COMMISSIONING TEST. I. REACTOR PHYSICS TESTS. Takeda, Atsushi (Japan Atomic Power Co., Tokyo). Nippon Genshiryoku Gakkaishi, 8: 584-91(Nov. 1966). (In Japanese).

Physics experiments undertaken during the commissioning of the Tokai Reactor are summarized. Stress is put on the description of the methods of analysis, and main results are given. Experiments and analysis have been carried out under the collaboration of the British General Electric Co. and the Japan Atomic Power Co. (auth)

10143 TOKAI REACTOR COMMISSIONING TEST. II. THERMAL ASPECTS IN PARTICULAR MEASUREMENT OF CORE FLOW DISTRIBUTION. Inomata, Toshio; Yamazaki, Ryokichi (Japan Atomic Power Co., Tokyo). Nippon Genshiryoku Gakkaishi, 8: 591-4(Nov. 1966). (In Japanese).

The most important limiting factor governing the operation of the Tokai Reactor is fuel element can surface temperature which is restricted from considerations of safety as well as from metallurgical aspects. Thus accurate assessment of fuel element can surface temperature is essential to assure safe and efficient reactor operation. For this purpose a computer program "Quicktem" has been developed. This program utilizes all the measured data available from the reactor to assess fuel element can surface temperatures and other values. The individual channel mass flow required for calculation however must be determined on the basis of "channel clearway" and "channel air flow" tests carried out during commissioning. These tests were not made solely for the above objectives, but also to report on the tests from the viewpoint of temperature assessment. The tests revealed close agreement of the core flow distribution with design, and no effect of gas duct and support grid on core flow distribution was observed. (auth)

10144 TOKAI REACTOR COMMISSIONING TEST. III. OTHER ZERO POWER TESTS. Mizuochi, Masashi (Japan Atomic Power Co., Tokyo). Nippon Genshiryoku Gakkaishi, 8: 594-7(Nov. 1966). (In Japanese).

The nuclear and thermal aspects of the commissioning tests conducted on the Tokai Reactor were reported earlier. Described are other zero power tests as well as engineering tests and inspections carried out in the period between full fuel loading and start of power raising. These tests are trial run with CO_2, calibration of burst cartridge detection gear, pressure vessel fast neutron flux measurement, and final inspection. These tests required twice as many days as originally expected, since some construction work was still in progress during this period. The test results were satisfactory. (auth)

10145 RECENT STUDIES IN NUCLEAR POWER PLANT SAFETY. II. EXPERIMENTAL STUDIES ON HEAT TRANSFER TO CORE SPRAY. Ichino; Ichiro; Sasaki, Mikio (Nippon Atomic Industrial Group Co., Japan). Nippon Genshiryoku Gakkaishi, 8: 602-8(Nov. 1966). (In Japanese).

A multirod fuel assembly was spray-tested to evaluate the feasibility and performance of a core spray cooling system to remove decay heat from the reactor core in the event of a loss-of-coolant accident. The test assembly consisted of 16 identical heat rods of 12 mm diameter, about 3 m effective heating length and 6 kW heat output per rod arranged in a square lattice inside a 71 × 71 mm stainless steel channel. The range of test variables covered included flow rates up to 30 l/min, heat fluxes up to 4 10^4 kcal/hr-m^2 and system steam pressures ranging from 0 to 6 kg/cm^2g. The results of the experimental data are (1) sprayed water particles did not flow down into the channel, obstructed by the upward steam flow induced by the vacuum created by spray cooling of the steam above the upper channel; (2) the heater was cooled by this up-flowing steam, and high values of heat transfer coefficient were observed; (3) correlation of the spray cooling data was within 20% using a McAdams equation for the steam. (auth)

10146 RECENT STUDIES IN NUCLEAR POWER PLANT SAFETY. III. SAFETY EVALUATION OF POST INCIDENT DEVICES OF LIGHT WATER POWER REACTOR. Fujie, Hideo (Hitachi Research Lab., Japan). Nippon Genshiryoku Gakkaishi, 8: 609-13(Nov. 1966). (In Japanese).

To evaluate the effectiveness of post incident safety devices for light water power reactors, experiments were performed on the cooling efficiency of spray, the flow rate of saturated water from a pressure vessel, the heat transfer of a container wall surface, and the cooling efficiency of container spray. Measurements of the temperature changes caused on heated rods (model fuel assembly) by spray cooling contributed to the formulation of a proposed theory to explain the temperature changes. The relationships existing between dry-out heat out-put and spray flow rate for stationary core spray cooling were obtained. The flow rate of saturated water from a model pressure vessel was measured and compared with Moody's theoretical results. The heat transfer coefficient of a container wall surface was measured with an apparatus installed in a model container and the variation of heat transfer with time and with inner-pressure of the container was determined. The relationship between cooling efficiency of container spray and inner-pressure of the container was obtained from experiments with a model container. (auth)

10147 RECENT DEVELOPMENT IN EARTHQUAKE RESISTANT DESIGNS FOR NUCLEAR POWER PLANTS IN JAPAN. Akino, Kinji (Japan Atomic Power Co., Tokyo); Shibata, Heki. Nippon Genshiryoku Gakkaishi, 8: 614-16(Nov. 1966). (In Japanese).

Recent developments in earthquake resistant designs for nuclear power plants in Japan are reviewed. A comparison of the design concepts and procedures between those of the plants constructed, under construction and being designed in Japan is given. The review covers the progress made in studies in this field, and the moves seen to utilize the results of these studies in setting regulations pertaining to nuclear safety. (auth)

10148 PROBLEMS OF CIVIL ENGINEERING RAISED THROUGH THE CONSTRUCTION OF REACTOR EL 4 AT BRENNILIS. Chaudesaigues, J. Ann. Inst. Tech. Baitment Trav. Publics, No. 213, 1113-35(Sept. 1965). (In French).

Problems associated with reactor unit structures erected at Brennilis, and in particular its prestressed concrete pressure vessel, are examined. The difficulties to be overcome included those associated with the size of the pressure vessel, which is a 48.0-m-high, 46.0-m-internal dia cylinder closed at the bottom by a flat floor and at the top by a 35.0-m-radius spherical dome. Three-dimensional prestressing of the pressure vessel solved the problems of chamber strength. (TCO)

10149 THE CIVIL ENGINEERING FOR NATURAL URANIUM–GRAPHITE–CARBON DIOXIDE GAS-TYPE NUCLEAR POWER STATIONS. Soulier, L. Construction (Paris), 20: 345-50(Oct. 1965). (In French).

The civil engineering aspects of natural U–graphite–CO_2-cooled nuclear power associated with the large dimensions of the structures, the accuracy with which they must be built, and new uses of materials are discussed. Structures such as the pressure vessels for reactors E.D.F. 3 and E.D.F. 4 can be illustrated by examining how the foundations are built, how the frame components are handled, acceptance of the structures, building tolerances, and the use of concrete as heatproofing material and protection against radiation or temperature. The speed and quality called for by this type of work are discussed. (TCO)

10150 SYSTEMS OF DATA PROCESSING EMPLOYED FOR MONITORING AND OPERATING NUCLEAR POWER STATIONS. Moinereau, P. Tech. Mod., 57: 403-6(Aug.-Sept. 1965). (In French).

Examples of data processing systems applications in experimental nuclear reactors are presented and computer applications in nuclear power stations are discussed. Functions provided by these systems include surveillance of analog measurements or all or nothing channels (failure or state contacts), and processing of burst slug detection. Standard systems of data processing for monitoring and automating nuclear power stations are described. (TCO)

10151 ASSESSMENT OF HIGH TEMPERATURE REACTORS. Engineer, 221: 856(June 3, 1966).

The present status and possible future of high-temperature reactors are summarized. A résumé of an address on this subject is given. (TCO)

10152 CHOICE OF OPTIMUM SHIELDING WALL MATERIALS FOR NUCLEAR PLANT BUILDINGS. Khlabynin, E. G. Sb. Tr. Mosk. Inzh.-Stroitel. Inst., 41: 65-86(1962). (In Russian).

Various materials are evaluated for possible use as shielding. Criteria for selecting optimum shielding materials for nuclear plants are discussed. These criteria include economics, ease of construction, and results required from the structure. (C.E.S.)

10153 STEAM-COOLED FAST REACTOR OF 1,000 MW. Engineer, 221: 868-9(June 3, 1966).

The design and evaluation of a steam-cooled fast breeder reactor of 1000 MW(e) was completed. A description of this work was presented at a recent conference of fast breeder reactors. A résumé of an address on the work is presented. (TCO)

10154 HINKLEY POINT "B." Nucl. Eng., 12: 26-8(Jan. 1967).

Technical details are given of the proposed 2 × 660 MW(e) design for the second commercial AGR power station. These show some significant extrapolations of the Dungeness "B" system, particularly in the increase of the gas pressure from 490 psi to 600 psi, while keeping the same basic layout. (UK)

10155 VULCAIN PROJECT: STATUS REPORT. Nucl. Eng., 12: 34-6(Jan. 1967).

The BR-3/Vulcain spectral shift small power reactor experiment attained full power of 11.7 MW(e) in December 1966, and it is intended to operate on base load for the next two years. The development of the system is described. Progress on the full-scale Vulcain prototype is summarized. (UK)

10156 INFLUENCE OF THE FUEL CYCLE IN SELECTION OF A NUCLEAR POWER REACTOR PROGRAM. Lartigue G., J. Rev. Soc. Quim. Mex., No. 204, 163-84 (Sept. 1965). (In Spanish).

Data and considerations regarding the world's needs in energy and the possible role of nuclear energy are presented. Classical reactors are described along with advanced reactors and their improvements. The present fuel cycle status is reported and technological and economical criteria are examined setting up the relations of fuel cost to the KW-hr cost as well as the future effects of reactor systems on the total profit accruing from nuclear resources. Conclusions are presented on the apparently best system for developing countries, and predictions by authorities in this topic are given. General and national forecasts are included. (auth)

10157 THE USE OF A DIGITAL COMPUTER FOR STARTING AND OPERATING THE EDF-3 NUCLEAR-POWER STATION. Morin, R. Energ. Nucl. (Paris), 8: 310-16(July-Aug. 1966). (In French).

The complexity of the atomic plant EDF-3 led to the use of digital computers which collect centrally all the important data on the operating conditions of the plant. The main computer processes 2500 measurements, and 3000 signals, records measured values and signals after a disturbance, detects leakage control of the canning, controls starting and shut-down operations, and records controls and adaptations of prescribed values. In case of failing of the main computer, its most important functions are overtaken automaticlly by an auxiliary computer. Investigations were made regarding the data reduction carried out by the computer to simplify the interpretations to be performed by the operating staff. (auth)

10158 THE IX GENERAL REPORT ON EURATOM'S ACTIVITIES. Comit. Naz. Energ. Nucl., Notiz., 12: No. 7, 29-35(July 1966). (In Italian).

A general report on the activities of Euratom from March 1965 through February 1966 is given. (auth)

10159 SENA NUCLEAR POWER STATION. Engineer, 222: 822-3(Nov. 25, 1966).

The design of the 242MW(e) Franco-Belgian power station at Chooz is described. The PWR, rated at 825MW(t), is situated underground. (UK)

10160 TIME OPTIMUM CONTROL FOR REACTORS WITH TWO KINDS OF INTERNAL FEEDBACK. Ogawa, Yuichi (Hokkaido Univ., Sapporo); Kaji, Ikuo; Ozawa, Yasutomo. J. Nucl. Sci. Technol. (Tokyo), 3: 455-64(Nov. 1966).

A control to bring the state of a reactor system to equilibrium state in time optimum manner is discussed. Non-linear integral equations containing the effects of two kinds of internal feedback and delayed neutrons and the effect of external control are adopted for the dynamic equations of the system. These equations are reduced to quasilinear (parametric) differential equations, on which the external control applies in the form of a combination of the control reactivity, its rate of change and its acceleration. Pontryagin's Maximum Principle is applied to a quasilinear system, and several modes of optimum control patterns — nodal, focal, saddle, and mixed — are obtained according to the nuclear and thermal properties, the thermal output of the reactor, and magnitude of the control. Optimum control is obtained in the form of piecewise constant control referred to a new control parameter which consists of a linear combination of the control reactivity, its rate of change, and its acceleration. (auth)

10161 ADIABATIC MODEL FOR SPACE-DEPENDENT BOILING WATER REACTOR KINETICS. Nishihara, Hideaki (Kyoto Univ.). J. Nucl. Sci. Technol. (Tokyo), 3: 486-90(Nov. 1966).

Space-dependent boiling water reactor kinetics are analyzed by the method of adiabatic approximation. Equations are derived for axially space-dependent BWR feedback kinetics. These equations are coupled to the neutron equations through adiabatic approximation. The reactor is divided into a number of axial regions. Assuming a trapezoidal distribution of the void and the water velocity distributions along the axis, balance equations for energy and mass are integrated to yield the region-exit quantities. With other pertinent equations, a computer code is written. (auth)

10162 CHEMISTRY OF THE FAST REACTOR FUEL CYCLE. Parkinson, N. (Dounreay Experimental Reactor Establishment, Eng.). J. Brit. Nucl. Energy Soc., 5: 551-7(Oct. 1966).

The use of plutonium in fast reactor fuels and its effects on the chemistry of fuel preparation and fabrication, in-pile behavior, and reprocessing of irradiated fuel are discussed. Preparation of plutonium fuel compounds, chemical properties of mixed oxides and carbides, effect of neutron irradiation on chemical reactivity, fabrication of oxides and carbides, reactions of fuels with cladding materials, chemistry of irradiated fuel, and reprocessing chemistry are considered. (M.C.G.)

10163 ELECTRICITY FROM NUCLEAR-FIRED GAS TURBINES? Holliday, J. B.; Hurst, J. N. (Rolls-Royce Ltd., Derby, Eng.). New Sci., 31: 610-13(Sept. 15, 1966).

The development potential of employing high temperature gas-cooled reactors and direct cycle gas turbines for electrical power production is examined. Various aspects of economic and technical limitations on plant design are compared for the conventional indirect steam cycle and a direct gas-turbine cycle. Comparisons are also made on typical gas-turbine systems using He or CO_2 coolants. (H.D.R.)

10164 BRITAIN'S SMALL REACTOR TAKES SHAPE. Fishlock, David. New Sci., 31: 564-6(Sept. 8, 1966).

The 100 MW(e) steam-generating heavy water reactor (SGHWR) prototype under construction at Winfrith Heath is described and some of its operational characteristics are discussed. Technical and economic aspects of the SGHWR are compared with those of conventional boiling- and pressurized-water reactor systems. (H.D.R.)

10165 TIME OPTIMAL DIGITAL COMPUTER CONTROL OF NUCLEAR REACTOR. II. DISCRETE TIME SYSTEM. Monta, Kazuo (Nippon Atomic Industry Group Co., Kawasaki, Japan). J. Nucl. Sci. Technol. (Tokyo), 3: 418-29(Oct. 1966).

A sampled data time optimal control of nuclear reactors has been developed using discrete versions of the Maximum Principle. The reactor model used is a second order nonlinear system derived by one group delayed neutron and prompt jump approximations. The control variable of the system is the rate of charge of reactivity, and for reasons of safety in reactor operation, this, as well as the reactivity, is restricted. In addition, the reactor power overshoot and undershoot are also restricted to devise a practical control. The discrete version of the Maximum Principle has been extended to deal with restricted state space problem, and with the

use of this extension, a time optimal control for nuclear reactors with pulse width modulated control input has been derived. The optimal control law is modified in the region around the terminal state, to obtain smooth control, and the stability of this modified control is verified by the second method of Liapunov. The results are directly applicable to digital computer control systems for nuclear reactors. (auth)

10166 REGIONAL NEUTRON-BALANCE METHOD FOR MULTI-GROUP CALCULATION OF MULTI-REGION FAST REACTORS. Nishihara, Hiroshi; Ohta, Masao (Kyoto Univ.). J. Nucl. Sci. Technol. (Tokyo), 3: 409-17(Oct. 1966).

A simple and quick method is proposed for one-dimensional multi-group calculations of multi-region fast reactors. This method is based on the condition of neutron-balance in each of the regions or subregions. Neutron flux distributions are represented by the simplest functions. It has been proved by a series of test computations that the accuracy is comparable to the ordinary diffusion theory calculations, while the computing time is saved by a factor of ten. (auth)

10167 A 6 MW HEAT TRANSFER LOOP AT WINFRITH. Obertelli, J. D.; Beasant, W. R.; Edwards, P. E. (Atomic Energy Establishment, Winfrith, Eng.). Nucl. Eng., 11: 795-9 (Oct. 1966).

Development of a facility for use in thermal performance studies of full-scale SGHW reactor channels is described. Basic requirements are summarized and design parameters associated with the high-pressure loop, the cooling-water loop, and power supply are discussed along with instrumentation and test section design. Design and development problems are outlined and information concerning the project timetable is included. (J.R.D.)

10168 PRE-STRESSED CONCRETE PRESSURE VESSELS FOR ELECTRICITE DE FRANCE. Nucl. Eng., 11: 790-4(Oct. 1966).

Design descriptions are given of the EDF4 vessel and the EDF3 vessel. Methods of construction are described along with test methods and results. (J.R.D.)

10169 CIVIL ENGINEERING WORKS AT BRADWELL, LATINA, DUNGENESS AND OLDBURY. Brown, A. Houghton; Johnson, O. Nucl. Eng., 11: 785-9(Oct. 1966).

Information is presented on site selection, foundation engineering and ground water control, and cooling pond design for the power stations. The design and construction of the prestressed pressure vessels at Oldbury are described. (J.R.D.)

10170 CONSIDERATIONS ON FISSION PRODUCT RELEASE SUPPRESSION FACTORS OF ENGINEERED SAFEGUARDS FOR NUCLEAR POWER PLANTS. Tagami, Takashi (National Reactor Testing Station, Idaho Falls, Idaho). Nucl. Eng. Design, 4: 214-23(Aug. 1966).

In a loss of coolant accident of a nuclear power plant, the amount of a specified nuclide among fission products released to atmosphere from the engineered safeguard consisting of an N-fold multiple barrier can be approximately estimated by the simple formula: $Q_{LN} = \alpha_m Q_0 K_0 K_1 K_2 \ldots K_N$, where $K_n = \alpha_n \beta_n / \lambda + \beta_n + \xi_n (n = 0, 1, 2, \ldots, N)$ is a fission product suppression factor associated with the nth barrier, Q_0 represents core fission product inventory referred to the specified nuclide which has a decay constant λ, α_m is the core meltdown fraction, α_n is the fission product nonremoval fraction due to absorption or adsorption through the nth barrier. β_n is the leak rate from the nth barrier, and ξ_n is the fission product removal rate due to the containment spray, air recirculation system or coolant vapor condensation inside of the nth barrier. Utilizing this formula, functions of various engineered safeguards proposed currently for light water moderated power reactor plants in the USA are reviewed with respect to the radioactive I_2 release suppression effects. (auth)

10171 CONTROL ROD I MECHANISMS. Nucl. Eng., 11: 800-1(Oct. 1966).

A review of established techniques of control rod design and operation is presented and trends in control systems for UK reactors are outlined. Information is included on control of Magnox-type reactors, advanced gas-cooled reactors, and prototype liquid-metal cooled fast reactors. (J.R.D.)

10172 EVALUATION OF A SATURATED STEAM CYCLE FOR A NUCLEAR POWER PLANT. Streeton, D. F. (Suiselectra A. G., Basel). Nucl. Eng., 11: 802-5(Oct. 1966).

It is noted that reactor costs are sufficiently low to offer attractive total energy costs for this type nuclear plant. Discussions are included concerning steam cycle arrangements, steam water separation, reheating, turbine design, and regulation of feedwater temperature. (J.R.D.)

10173 STRUCTURAL CHARACTERISTICS OF CYLINDRICAL PRESSURE VESSELS OF MEDIUM THICKNESS. Tottenham, H.; Kanchi, M. B. (Univ. of Southampton, Eng.). Nucl. Eng. Design, 4: 177-92(Aug. 1966).

A flat-headed cylindrical pressure vessel is analyzed for the redundant forces and stresses at the junction using a Reissner type theory. The flexibility coefficients and other functions required in the structural analysis of the vessel are tabulated for different ratios of thickness to radius, and general formulas are given for the determination of forces and displacements. The theory used resembles that proposed by Reissner and Nagdhi but differs in details. The complete set of the constituent equations for the general case of a shell of arbitrary shape are listed. The analysis can be used to estimate the corrections to be applied in the analysis of prestressed concrete pressure vessels when using the thin-walled shell theory. (auth)

10174 GENERAL DESCRIPTION OF THE LATTICE CODE WIMS. Askew, J. R.; Fayers, F. J.; Kemshell, P. B. (Atomic Energy Establishment, Winfrith, Eng.). J. Brit. Nucl. Energy Soc., 5: 564-85(Oct. 1966).

The Winfrith improved multi-group scheme (WIMS) is a general code for reactor lattice cell calculations on a wide range of reactor systems. In particular, the code will accept rod or plate fuel geometries in either regular arrays or in clusters and the energy group structure has been chosen for both thermal and fast reactor calculations. The basic library has been compiled with 14 fast groups, 13 resonance groups and 42 thermal groups, but the user is offered the choice of accurate solutions in many groups or rapid calculations in few groups. Temperature dependent thermal scattering matrices for a variety of scattering laws are included in the library for the principal moderators which include hydrogen, deuterium, graphite, beryllium and oxygen. The treatment of resonances is based on the use of equivalence theorems with a library of accurately evaluated resonance integrals for equivalent homogeneous systems at a variety of temperatures. The Spectrox collision theory procedure gives accurate spectrum computations in the 69 groups of the library for the principal regions of the lattice using a simplified geometric representation of complicated lattice cells. The computed spectra are then used for the condensation of cross-sections to the number of groups selected for solution of the transport equation in detailed geometry. Solution of the transport equation is provided either by use of the Carlson DSN method or by collision probability methods. Leakage calculations including an allowance for streaming asymmetries may be made using either diffusion theory or the more elaborate B_1-method. The output of the code provides eigenvalues for the cases where a simple buckling mode is applicable or cell-average parameters for use in overall reactor calculations. Various reaction rate edits are provided for direct comparison with experimental measurements. Detailed accounts of the resonance treatment, Spectrox procedure, and leakage methods are given. (auth)

10175 ON-LINE OPTIMIZATION OF NUCLEAR REACTOR LOAD CONTROL IN THE PRESENCE OF NONLINEARITIES. Duncombe, Eliot. Pittsburgh, Univ. of Pittsburgh, 1965. 148p. Thesis.

Optimal control systems are developed, for a pressurized water nuclear reactor plant, with respect to load demand changes in the secondary system. Parameters of the feedback network are optimized by means of a Hamiltonian formulation of the trajectory equations. The mixed boundary value problem resulting from the canonical Hamiltonian equations is converted into an initial value problem in the form of matrix Riccati equations which are solved at high speed by analog methods. The control rod position is thus calculated almost instantaneously as a function of the existing values of the plant variables and the load demand setting. The nonlinear reactor plant equations are linearized by the use of a new variable, which is the product of core power and reactivity and appears both in these equations and in the performance index. An alternative method is also employed whereby the required feedback network is obtained by expansion about the equilibrium values of the plant variables which are set by the load demand. The load demand, which enters into the plant equations in a nonlinear manner, is treated as a time-dependent parameter. Two performance indices are considered, one which directly penalizes changes in core power error, and the other which penalizes volume surges into or out of the primary system pressurizer. The reactivity control requirement, multiplied by a suitably chosen weighting factor, is also included in the performance indices. The control systems are verified by means of a simulated typical reactor plant. Solutions to the matrix Riccati equations determining the feedback network parameters are obtained in a stable manner for all load demand changes including step functions. Optimal trajectories for ramp rates of power increase and decrease are obtained for various values of reactivity weighting factor. (auth)

10176 FEATURES OF SECOND GENERATION SODIUM-COOLED FAST REACTORS. Amorosi, Alfred; Peters, Norman T. (Atomic Power Development Associates, Inc., Detroit). 14p. (CONF-660606-20). ORAU. Gmelin, AED-CONF-66-203-36.

From American Nuclear Society Meeting, Denver.

A discussion is presented of a hypothetical Fermi II (500-MW(e)) plant, and of some features that should be considered in such a plant if maximum use is made of the Fermi I plant experience. Fuel and core design, fuel handling, and heat transfer system components are considered. Some design changes are recommended. (D.L.C.)

10177 OYSTER CREEK NUCLEAR BOILER DESIGN. Elliott, V. A.; Kanne, W. R. (General Electric Co., San Jose, Calif.). 19p. (CONF-660429-1). ORAU. Gmelin, AED-CONF-66-098-4.

From American Power Conference, 28th Annual Meeting, Chicago.

The Oyster Creek Nuclear Boiler is typical of the large boiling water reactors with capacities in the 500-MW(e) range scheduled for startup in 1967–1968. The design incorporates many features which have led to compaction, simplification, improved operability and improved economies. The scope of this paper covers the Nuclear Boiler, including the core. (auth)

10178 LUBRICATION OF NUCLEAR POWER PLANTS AND NUCLEAR POWERED VESSELS. Barnett, R. S. (Texaco Research Center, Beacon, N. Y.). 61p. (CONF-611002-1). ORAU.

From Society of Naval Architects and Marine Engineers, Northwest Section, Fall Meeting, Gearhart, Oreg., Oct. 1961.

After a brief review of atomic structure and nuclear energy, stationary nuclear plants and nuclear propulsion are discussed. Radiation effects on petroleum products are described, and lubrication problems in nuclear power plants are considered for both stationary plants and nuclear-powered vessels. Equipment for radiation studies on petroleum is described briefly. Finally, lubrication aspects of the N.S. Savannah are discussed. (D.L.C.)

10179 NUCLEAR REACTOR WITH THERMIONIC CONVERTER. Grover, George M.; Bohdansky, Josef; Busse, Claus A. (to U. S. Atomic Energy Commission). U. S. Patent 3,302,042. Jan. 31, 1967.

A nuclear reactor heat removal system is described comprising heat pipes having capillary linings extending into the reactor components from the exterior of the reactor and containing condensable vapors. The heat pipes can be employed as the heating means for thermionic energy converters. (AEC)

10180 IN-CORE SAMPLING AND SPRAY DEVICE FOR NUCLEAR REACTORS. Jerman, Ralph B.; Santoro, Peter F.; van Kessel, Henri F. (to U. S. Atomic Energy Commission). U. S. Patent 3,300,388. Jan. 24, 1967.

A probe for detecting failure of fuel-element assemblies composed of several closely spaced jacketed fuel elements over and between which water is flowed. The probe is located at the exit end of the fuel-element assembly and comprises a manifold extending radially outward from a collecting line located on the axis of the assembly. Each manifold tube is closed at its outer end and has a plurality of openings spaced along its length through which a mixture of steam, water, and gaseous fission products from the fuel-element assembly enters the tube and passes to the collecting line and thence to processing apparatuses. (AEC)

10181 SHUTDOWN REACTIVITY METER FOR MEASURING THE SUBCRITICAL REACTIVITY IN A NUCLEAR REACTOR. Schultz, M. A.; Shaw, V. G.; Bluestein, I. (to U. S. Atomic Energy Commission). U. S. Patent 3,296,440. Jan. 3, 1967.

A meter for automatically and continuously measuring the subcritical reactivity of a shutdown nuclear fission reactor is described. The meter analyzes the noise generated in the reactor core arising from the fluctuations in neutron density. The ratio of energy centered at a high frequency to that at a low frequency becomes a direct measure of this reactivity. (AEC)

10182 VALVE CONSTRUCTION. Underhill, Harvey J. (to Atomic Energy of Canada Ltd.). Canadian Patent 744,598. Oct. 18, 1966. Priority date May 11, 1964, United States.

A dump valve mechanism is described to shut down a nuclear reaction quickly by gravity flow of the heavy water moderator which normally surrounds the fuel. In the operating position the valve gate in the bottom of the reactor is held closed against gravity and the heavy water head by magnetic attraction. A suitable gasket arrangement uses the weight of the heavy water to form a satisfactorily tight closure. Rapid shutdown is accomplished by cutting off the power to magnetic closing device. Failure of the normal control system or power supply causes automatic shutdown by removal of the magnetic flux. The valve operates in a pipe of such dia that fission ceases in a few seconds because heavy water soon falls to a subcritical level. (F.S.A.)

10183 NUCLEAR REACTORS. Wildgoose, Ronald. (to U. S. Atomic Energy Commission). U. S. Patent 3,296,081. Jan. 3, 1967.

A control rod position indicating device is described comprising a transformer attached to the control rod, the transformer having a pair of series connected windings, and a hollow member of magnetic materials surrounding the control rod, the hollow member having a different internal dimension adjacent one of said windings when the control rod is in its bottom position. (AEC)

10184 CALANDRIA CORE FOR SODIUM GRAPHITE REACTOR. Peck, W. S.; Duncan, R. S.; Williams, A. C. (to U. S. Atomic Energy Commission). U. S. Patent 3,296,085. Jan. 3, 1967.

A nuclear reactor core structure design is described having a core tank containing a graphite moderator, channel process tubes through the moderator, containing fuel elements cooled by Na, and the core tank supported from a beam which is positioned above the tank. (AEC)

10185 BOILING COOLANT REACTOR WITH IMPROVED RECIRCULATION AND BY-PASS CONTROL ARRANGEMENT. Williams, Ronald Peter (to United Kingdom Atomic Energy Authority). U. S. Patent 3,275,524. Sept. 27, 1966. Priority date Jan. 8, 1963, Great Britain.

A method is described for the control of the reactivity of a boiling coolant reactor, particularly a boiling water reactor, by recirculation and/or by-pass of a part of the coolant. In one aspect of the design, a recirculation line is provided for forced recirculation of a liquid coolant through the reactor core at a variable rate. The rate of forced recirculation can be altered by the addition of a core by-pass line for carrying coolant from the recirculation line into heat exchange relationship with the boiling coolant within the reactor to cause condensation there. A valve is provided to control the flow of coolant through the by-pass line. Alternatively, the core by-pass line from the recirculation line can communicate with an injector to inject liquid coolant into the boiling coolant within the reactor. In this case, a valve in the by-pass line affords simultaneous control of the recirculation rate and of the rate of injection. (B.L.M.)

10186 SEGMENTED NUCLEAR REACTOR CORE HAVING PIVOTABLE OUTER CONTROL ASSEMBLIES. West, John M.; Bevilacqua, Frank (to Combustion Engineering, Inc.). U. S. Patent 3,276,964. Oct. 4, 1966. Filed May 31, 1960.

A design is patented for a boiling water reactor in which the core is divided into two regions, a fixed inner vertically disposed region and an adjacent outer laterally movable region. This outer region is made up of several sections that may be positioned in varying places from the ultimate away from the inner portion, in which case the reactor is sub-critical, to a position adjacent to the inner region. These outer sections are so mounted that they are urged by gravity to their outermost position to provide safety in case of accident. The core design may also be combined with a certain number of conventional type control rods, but the number of rods necessary to control the reactor is greatly diminished with this core arrangement. The core arrangement is suitable for use in reactors cooled entirely by natural circulation or by forced circulation through the fixed inner core portion and natural circulation through the movable outer region. (B.L.M.)

10187 IMPROVEMENTS IN OR RELATING TO NUCLEAR REACTOR FUEL ELEMENTS. Eyre, Philip Bernard; Parry, Paul Ivor (to United Kingdom Atomic Energy Authority). British Patent 1,040,159. Aug. 24, 1966. Filed July 23, 1962.

A fuel element design of the type in which right cylindrical pellets of the fuel material are encased in a sheath and sealed with welded end caps is patented to prevent the jamming or packing of fuel pellets at temperatures below reactor operating temperatures to result in fracture of the end welds. A load bearing pellet is provided in frictional engagement with the sheath between each end of the column of fuel pellets and the end caps closing the ends of the sheath. The sheath is externally pressurized into frictional engagement with the load bearing pellets. (B.L.M.)

10188 HIGH TEMPERATURE GAS COOLED REACTORS WITH INTERNAL FISSION BY-PRODUCT TRAPPING MEANS. Kinsey, Denis Victor; Valette, Leon Jean; Lothe, Johan (to United Kingdom Atomic Energy Authority). U. S. Patent 3,275,522. Sept. 27, 1966. Priority date Mar. 28, 1962, Great Britain.

A graphite fuel bearing component for removing impurities from the coolant gas stream is described for use in a high temperature gas-cooled reactor. The core of the reactor is composed of material that is susceptible to corrosion by the impurities CO_2 and water vapor present in the coolant. The defined flowpath for the coolant gas includes an inlet portion, an intermediate portion ex-

tending in close proximity with the fuel bearing components, and an outlet portion. Positioned in the inlet portion is a porous reactive body for the removal of the impurities and formed of a gettering material selected from the group consisting of Ti, Zr, Zr–Ti alloy, and Zr–Al alloy or of porous graphite incorporated with small quantities of materials selected from the group consisting of Ba, Sr, and Ni. (B.L.M.)

10189 FAST BREEDER REACTOR ARRANGEMENT. Schluderberg, Donald C.; Winders, Gordon R. (to The Babcock and Wilcox Co.). U. S. Patent 3,275,521. Sept. 27, 1966. Filed Nov. 15, 1963.

A fast breeder reactor includes a pressure vessel having a number of fuel elements arranged as the core to undergo fission reaction and having an operating neutron spectrum energy level substantially above the thermal neutron level. A number of elements containing a nuclear fertile material are arranged to form the breeder blanket around the core. The coolant fluid is passed serially up through the blanket elements laterally surrounding the core and then downwardly through the fuel elements. The coolant fluid is a single phase hydrogen-isotope-bearing fluid capable of a substantial change in density with a change in heat content. The preferred coolant is supercritical steam containing either H_2O or D_2O or a combination of the two. Thus the reactor is controlled by the variation either of the density of the fluid or of the composition of the fluid in the core. (B.L.M.)

10190 SHIELDING ARRANGEMENT FOR NUCLEAR REACTORS. Fendler, Heinz Gerhard; Ringeis, Wilhelm (to Licentia Patent-Verwaltungs-GmbH). U. S. Patent 3,280,330. Oct. 18, 1966. Priority date Nov. 24, 1959, Germany.

A method to prevent the migration of radioactive gases through the pressure vessel into the gas in the space between the pressure vessel and the biological shield of a reactor consists of coating the outer surface of the pressure vessel and/or the inner surface of the biological shield with neutron absorbing material. This also eliminates the necessity of special precautions to remove the radioactive contaminants before the cooling gases for the biological shield are exhausted to the atmosphere. The preferred coating is a foil of a Ag–Cd–In alloy, but compounds or alloys of B, Cd, or Gd may also be used. (B.L.M.)

10191 FUEL ELEMENT WITH IMPROVED PURGE GAS ARRANGEMENT. Vanslager, Francis E. (to General Dynamics Corp.). U. S. Patent 3,274,070. Sept. 20, 1966. Filed May 31, 1963.

A fuel element for a gas cooled reactor operating at high temperatures is comprised of a number of elongated body pieces having a bore extending longitudinally through them. A number of fuel chambers for containing fissionable material are contained along the walls of the bore. A connecting means for holding the pieces in coaxial alignment with one another is also provided with a bore to provide communication between the bores of the body pieces. The connection means has an enlarged section intermediate between its ends and has beveled surfaces on this enlarged section to engage correspondingly beveled surfaces on the body pieces. A passageway in the walls of the connector provides communication between the chambers in the body pieces, and interengaging means on the retaining means and on the body pieces prevent longitudinal movement of the body pieces relative to the retaining means. The flow path of the coolant gas is into the chamber of one body piece through the retaining means and into the chamber of another body piece. This fuel element is designed to eliminate the bowing usually experienced with fuel elements operating at temperatures in excess of 1800°F. (B.L.M.)

10192 REFUELLING DEVICE FOR NUCLEAR REACTORS. Aubert, Michel; Brouard, Daniel; Rouge, Pierre (to Commissariat a l'Energie Atomique). U. S. Patent 3,279,627. Oct. 18, 1966. Priority date July 31, 1963, France.

A refuelling device designed for use with solid-moderated, gas-cooled reactors comprises a handling system that is placed within the reactor containment shielding inside a compartment that is separated from the core chamber by a wall pierced with obturable openings providing access to the fuel channels. Provision is made for transferring the elements between the channels and a storage magazine. The insertion and withdrawal device comprises a lock-chamber disposed within a horizontal tunnel that provides access to the servicing chamber and separates this part of the system from other parts that are maintained at atmospheric pressure. A seating having a horizontal axis formed in the tunnel wall is provided within the tunnel. A rail is carried by the wall and has a break at the level of the seating. A rotary system consisting of a base-plate is rotatably mounted on a vertical pivot supported by the bottom portion of the tunnel wall. A flap that is capable of being applied against the seating serves to open or close the tunnel as the rotary part is moved about the pivot point. A rail segment is secured to the base-plate and is adapted to span the gap in the rail secured to the tunnel wall when the flap is in the open position. (B.L.M.)

Marine and Portable Power Reactors

Refer also to abstract 10178.

10193 (IAE–1181) ISPYTANIE I ISSLEDOVANIE OPYTNOI SBORKI STERZHNEVHKH TVEL S SERDECHNIKAMI IZ CPECHENNOI DVUOKICI URANA V OBOLOCHKAKH IZ TSIRKONIEVOGO SPLAVA, DOSTIGSHEI MAKSIMALNOGO VYGORANIYA 68000 MVT. SUT/T URANA. (Tests and Analysis of an Experimental Assembly of Nuclear Fuel with Sintered Uranium Dioxide Cores in Zirconium Alloy Jackets with Maximum Uranium Burn Up of 68000 MWD/t). Amaev, A. D.; Ambartsumyan, R. S.; Goncharov, V. V.; Glukhov, A. M.; Dubrovin, K. P.; Ivanov, E. G.; Lebedev, L. M.; Pravdyuk, N. F.; Ryazantsev, E. P. (Gosudarstvennyi Komiter po Ispol'zovaniyu Atomnoi Energii SSSR, Moscow. Institut Atomnoi Energii). 1966. 36p. (In Russian). Dep. mn.

The results of loop tests and investigation in a hot laboratory assembly TVEL for the reactor of the ice breaker "Lenin" were reported. The reactor has very high burnup equal to 68,000 MWd/t. The test conditions in the water loop of the high-pressure reactors RFT and MP were discussed, and on the basis of the tests, conclusions were made on the behavior of the zirconium alloys and sintered uranium oxide during extended irradiation in a reactor and on the efficiency of the assembly of heat-releasing elements. (tr-auth)

10194 (ORNL–TM–1676) CHARACTERIZATION OF ARMY PM-1 TYPE REACTOR FUEL ELEMENTS. Hobson, D. O.; Haynes, V. O.; Crouse, R. S. (Oak Ridge National Lab., Tenn.). Dec. 1966. Contract W-7405-eng-26. 44p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Results are presented of the characterization and evaluation of a number of PM-1 type, stainless steel-UO_2 fuel elements to better define the as-manufactured physical characteristics of the elements and to provide data for comparison with elements in the postirradiated condition. The primary objectives attained in this study were quantitative information on cladding-fuel bonding and cladding-fuel interface contamination, fuel particle stringering and fragmentation, and cladding grain size. Other information concerning fuel homogeneity and density is included. Some analyses of the probable causes of observed defects are presented. The fuel tubes were judged to be of consistent high quality with the fuel particles well dispersed in the matrix. Although severely fragmented, the particles were stringered very little. Core density was uniformly around 96% of theoretical. Despite a large amount of particulate contamination between the cladding layers, grain growth had occurred across nearly all of the interfaces. The cladding grain size ranged from ASTM-2 to ASTM-5. (auth)

10195 EFFECTS OF HEAVING AND LISTING UPON THERMO-HYDRAULIC PERFORMANCE AND CRITICAL HEAT FLUX OF WATER-COOLED MARINE REACTORS. Isshiki, Naotsugu (Ship Research Inst., Tokyo). Nucl. Eng. Design, 4: 138-62(Aug. 1966).

Burn-out was observed in two simplified atmospheric models of marine water-cooled reactor core-loops on which cyclic heaving motions and constant listing were applied. Cyclic heaving motions up to ±1.1 gravity amplitude and 30° list were employed. Thermal and hydraulic performance is described. (J.R.D.)

Rocket and Space Reactors

Refer also to abstract 8513.

10196 (N–66–30084) AEROSPACE MEDICINE AND BIOLOGY. A Continuing Bibliography with Indexes. (National Aeronautics and Space Administration, Washington, D. C.). June 1966. 193p. (NASA-SP-7011(25)). CFSTI $3.00 cy, $0.65 mn.

Abstracts and indexes are compiled for researches dealing with biological, environmental, physiological, and psychological effects to which man is subjected during simulated and actual space flights. References describing similar effects on lower forms of life are included; and attention is given to such related topics as life support systems, safety and survival, and sanitation. While the emphasis is placed on applied research, there are numerous references to theoretical experiments. This is part of a continuing bibliography that includes abstracts of articles previously announced by the American Institute of Aeronautics and Astronautics, the Library of Congress, and NASA. (STAR)

10197 (N–66–32206) RADIATION SHIELDING CONSIDERATIONS FOR INTERPLANETARY SPACECRAFT. Kottler,

Carl F. Jr. (Grumman Aircraft Engineering Corp., Bethpage, N. Y. Research Dept.). Jan. 1966. 52p. (RE-236).

Presented is an analysis of the radiation dosage astronauts would receive when protected by various combinations of passive shielding, as a function of mission duration and the probability of exceeding the statistically predicted dosage of the NASA Model Solar Proton Environment. Dosages to the internal organs and the skin (taking into account self-shielding) are determined as a function of the energy of the incident particles, and are compared with permissible dosages. The shielding and associated effective cutoff energies required for protection against alpha particles and protons are calculated for mission durations between 1 week and 2 years, with three probabilities of exceeding the indicated dosages (0.1, 0.01, and 0.001). The data permit comparison between magnetic or electrostatic shielding and passive shielding on the basis of radiation dosage and emission duration. Parametric curves for typical Al structure, polyethylene shield, H_2-fueled spacecraft are shown. An introductory description of the solar atmosphere, solar activity, and associated geomagnetic phenomena is also presented along with reference tables. (auth)

10198 (N-66-20195) PROBLEMS OF RADIATION SAFETY OF SPACE FLIGHTS. Volynkin, Yu. M.; Saksonov, P. P.; Antipov, V. V.; Savenko, I. A. (Akademiya Nauk SSSR). Translation of a Russian Report. 14p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Problems of radiation safety during space flight are discussed, including: investigation of physical parameters of cosmic radiation; determination of relative biological effectiveness of individual components of cosmic radiations; elucidation of specific contribution of cosmic radiation to the biological effect of space flight factors; investigation of the effect of cosmic radiation on heredity and variability of organisms; determination of admissible limit radiation doses for space flights; development of methods for dosimetry of ionizing radiations aboard space vehicles; development of effective means of physical and pharmacochemical protection of organisms against radiations; and selection of orbits least dangerous in radiation aspects. (auth)

Process Heat and Desalination Reactors

10199 (ORNL-TM-1564) FLEXIBILITY IN PRODUCTION OF POWER AND WATER FROM NUCLEAR DESALTING PLANTS. Franzreb, J. K.; Spiewak, I. (Oak Ridge National Lab., Tenn.). Sept. 1966. Contract W-7405-eng-26. 63p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Flowsheets were developed for flexibility in the product output of dual-purpose nuclear desalting plants with base-load rating 500 MW(e) and 250 M gal/day. The base plant has a 3228 MW(t) pressurized water reactor, a back-pressure turbine-generator, and a multi-stage flash evaporator. The performance and cost of alternative systems for providing flexibility were evaluated by means of a computer model of the plant. Among the systems investigated were variable back pressure turbines, optional low pressure condensing turbines, pumped storage, turbine bypass desuperheaters, optional evaporator modules, vapor compression, and heat pumps. Some of these systems appeared to be useful for providing economical peak power, for spinning reserve, in trading power for water, or in operating at mismatched product demand. (auth)

Research and Test Reactors and Critical Assemblies

Refer also to abstract 8621.

10200 (AECL-2579) METHOD OF CALCULATING ASYMPTOTIC AND TRANSIENT MATERIAL BUCKLINGS OF A UNIFORM ROD LATTICE. Stewart, J. D. (Atomic Energy of Canada Ltd., Chalk River (Ontario)). Oct. 1966. 31p. Dep. mn. AECL $1.00.

This method of calculating bucklings is based on the "macroscopic flux condition," an approximate relation between the fluxes and gradients at the boundary of a lattice cell and the corresponding quantities for the corresponding homogeneous medium. Diffusion theory is assumed to hold for fast and thermal neutrons in the moderator. This method can be applied, for example, to cases where lattice diffusion parameters such as the diffusion coefficient, although they can be said to exist, depend on the buckling and may be awkward to compute even when that buckling is known. (auth)

10201 (AECL-2626) NEUTRON SPECTRUM MEASUREMENTS IN NON-MULTIPLYING AND MULTIPLYING MEDIA. Jong, R. A.; Serdula, K. J. (Atomic Energy of Canada Ltd., Chalk River (Ontario)). Aug. 1966. 54p. Dep. mn. AECL $1.50.

Measurements of the effective neutron temperature and the Westcott epithermal index (r value) were made in (i) nonmultiplying media and (ii) multiplying media. In part (i), neutron temperature and r values were derived from neutron activation measurements in the D_2O and graphite reflectors of the ZED-2 reactor. The effective neutron temperature of the graphite was found to be about 6°C higher than the temperature in D_2O, for $r \leq 0.0013$. In part (ii), neutron temperature and r values were derived from neutron activation measurements in 19-element and 7-element UO_2 fuel assemblies in the central cell of the ZEEP reactor. Three coolants were used in the assemblies, D_2O, H_2O, and an organic liquid, HB-40. The H_2O coolant produced a spectrum that was consistently softer (15–20°C) than that produced by the HB-40. Differences in bundle geometry produced appreciable neutron temperature changes with the hydrogenous coolants but only a small effect with D_2O coolant. (auth)

10202 (ANL-7168(Vol.2)) FAST REACTOR TEST FACILITY (FARET). VOLUME II. SUMMARY OF PRELIMINARY SAFETY ANALYSIS. Geier, J. D. (ed.) (Argonne National Lab., Ill.). Apr. 1966. Contract W-31-109-eng-38. 179p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

This volume covers the safety analysis and related work which took place during AEC considerations of the FARET preliminary safety analysis. The possible circumstances leading to the maximum credible accident and its subsequent effects are described and evaluated. Results are given of other analyses which were performed on less serious accidents. A summary of Volume I (facility description) is given in the appendices. (D.L.C.)

10203 (BNWL-SA-256) IRRADIATION OF IMPACTED UO_2–PuO_2. Bailey, W. J. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Nov. 3, 1965. Contract AT(45-1)-1830. 35p. (CONF-651101-40). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

From 13th Conference on Remote Systems Technology, Washington, D. C.

Radiation effects on Zircaloy-clad vibrationally-compacted UO_2–1.5 wt % PuO_2 fuel rods are reported. Evaluation is made of fission gas release, sintering, fission product migration, and compatibility of stainless steel springs located in the fuel element plenum. (P.G.C.)

10204 (ORNL-P-2555) EXPERIENCE IN COMPUTING RESEARCH REACTOR FUEL BURNUP CONTRASTED WITH RECOVERY RESULTS. Hamrick, T. P.; Stringfield, H. F. (Oak Ridge National Lab., Tenn.). [nd]. Contract W-7405-eng-26. 18p. (CONF-661011-6). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

From AEC Contractors' Nuclear Materials Management Meeting, Berkeley, Calif.

Methods and formulas for computing burnup of nuclear fuels, including sources of error, and adjustments required to minimize errors are reported. Theoretical and actual recovery values of spent fuels are compared. (P.G.C.)

10205 (SC-RR-65-587) THERMAL SHOCK MEASUREMENTS ON THE WHITE SANDS MISSILE RANGE FAST-BURST REACTOR. Reuscher, J. A. (Sandia Corp., Albuquerque, N. Mex.). Aug. 1966. Contract AT(29-1)-789. 16p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Strain gage techniques were used to measure the loads imposed on the support structure of the White Sands Missile Range Fast-Burst Reactor during burst operation. The data are summarized for a series of 17 bursts varying in yield from 9.1×10^{15} to 6.2×10^{16} fissions. (auth)

10206 EVALUATION OF THE COEFFICIENT OF B^6 TERM IN THE DECAY CONSTANT OF FUNDAMENTAL MODE FOR BeO. Navalkar, M. P.; Ramakrishna, D. V. S. (Atomic Energy Establishment, Trombay, India). J. Nucl. Energy: Pt. A and B, 20: 971-5(Nov.-Dec. 1966).

The neutron flux in the case of pulsed finite moderator assemblies has been expanded in powers of B^2, following the method of Nelkin and Beckurts. Expressions for the diffusion cooling coefficient and the coefficient of B^6 term have been derived both on diffusion and transport theory. Using the Nelkin kernel in the incoherent approximation and transport cross sections as given by Singwi, these parameters have been evaluated for BeO moderator. Numerical calculations have been done with an energy mesh of 0.9 MeV and cut-off energy of 0.3 eV. The theoretical value of 3.4×10^5 cm^4 sec^{-1} for the diffusion cooling coefficient is on the lower side of the experimental value which lies between $(3.5-6) \times 10^5$ cm^4 sec^{-1}. In view of the large experimental errors on F-coefficient, no conclusion could be drawn. On the basis of the theoretically calculated negative F-value, one concludes that the thermalization power for BeO decreases with a decrease in neutron temperature. (auth)

10207 ELECTROPHORETIC FILTER FOR PURIFYING REACTOR WATER. Ganzha, V. D.; Egorov, A. I.; Kaminker, D. M.; Kolyadin, A. V.; Konoplev, K. A.; Saikov, Yu. A.; Sharov, V. T. J. Nucl. Energy: Pt. A and B, 20: 993-9(Nov.-Dec. 1966).

As the result of corrosion, aluminum hydrate formed in the water of the main circuit of the reactor of the A.F. Ioffe Physico-technical Institute of the Academy of Sciences of the U.S.S.R. and was difficult to dissolve. An electrophoretic filter of special design made it possible to clean the coolant of the main circuit completely. The filter has a total capacity of 10.7 liters, its hydraulic resistance is low, and it is easy to service. The effective discharge through the filter is 0.5 m^3/hr. The power employed is 0.3 kW. (tr-auth)

10208 RADIOGRAPHIC INVESTIGATION OF THE MICRO-DISTRIBUTION OF NUCLEAR FUELS IN THIN LAYERS. Neider, Rudolf; de Meester, Paul (Studiecentrum voor Kernenergie, Mol, Belg.). Materialpruefung, 8: 251-5(July 1966).

The fuel elements of most high-flux materials-testing reactors are assemblies of rolled plates or coextruded tubes. For the BR-2 reactor, the plates or tubes consist of a 90% enriched U 24%–Al alloy core and are clad with aluminum. For investigation of the microdistribution of the fuel the plates or tubes are radiographed with 60-keV x rays while a fine-grained photographic emulsion is in intimate contact with the investigated area. The fuel distribution is checked qualitatively by 10- to 30-fold enlargements of the film on paper and quantitatively by photometric density measurements. The maximum resolution is about 30 μm. (auth)

10209 STUDY ON SOME MODELS OF NEUTRON THERMOPILES. Cervellati, R.; Gislon, R.; Rispoli, B. (Centro Studi Nucleari, Casaccia, Italy). Nucl. Instrum. Methods, 45: 221-32 (Dec. 1966).

Neutron thermopiles are described and discussed as a tool for in-core measurements. Theoretical considerations permit the evaluation of the sensitivity of the instrument under various conditions of reactor power, neutron spectrum, sensitive material, filling gas, thermal insulation. Other characteristics such as time response and life are also considered. The perturbation introduced by the probe in the surrounding neutron flux is discussed as well. Experimental results, obtained by measurements from 27 mounts tested in a Triga reactor, are given. Among them are: the thermal neutron sensitivity, an effect of sensitivity decrease, a comparison of some identical probes, the gamma sensitivity, the flux perturbation, the intrinsic noise, the time response, and the activation. It was possible to obtain watertight miniaturized probes, having a sensitivity of 1×10^{-15} V/n · cm^2 · sec, 1 sec response time, and a life of some hundreds h in 10^{12} n/cm^2 · sec. (auth)

10210 MEASUREMENT AND ANALYSIS OF THERMAL DISADVANTAGE FACTOR FOR UO_2–H_2O LATTICES. Kobayashi, Setsuo (Hitachi, Ltd., Tokyo). J. Nucl. Sci. Technol. (Tokyo), 3: 363-72(Sept. 1966).

Dy-activation disadvantage factors for seven UO_2-H_2O lattices were measured and compared with the results calculated by AMOUYAL, THERMOS and GRAFA codes. The experimental value does not decrease monotonically with decrease of the volume ratio, and GRAFA gives results in good agreement with these experimental values. In order to further examine these results, one of the thermal neutron spectrum parameters, the Lu-Cu activation ratio, which also was measured in another experiment, was compared with the calculated results. Thermal neutron spectra of the individual regions in a lattice calculated by various current computations are softer than those determined by experiment. These differences are particularly large in the moderator regions. It is shown that the two dimensional multigroup collision probability model calculated by GRAFA gives results in good agreement with experimental values for the disadvantage factor, and that the cylindrical cell approximation with isotropic or reflecting boundary condition gives poor results in closely packed lattices. (auth)

10211 ASTR LOSS OF FLUID COOLANT TEST. Lawrence, R. A. (Southern Methodist Univ., Dallas); Pancoast, J. T. 24p. (CONF-660606-43). ORAU. Gmelin, AED-CONF-66-203-108.

From American Nuclear Society Meeting, Denver.

An experiment was conducted to determine the consequences of the complete loss of coolant from the 10-MW Aerospace Systems Test Reactor (ASTR). A heat transfer model was developed for analysis of the thermal response of ASTR. In the experiment, ASTR was instrumented with thermocouples, and a water expulsion system was used to simulate immediate loss of coolant. Thirteen reactor runs were performed, with four in water and the rest in air. Equations were derived for the heat capacity and heat-loss coefficient. The graph of the ASTR thermal response shows a time span of $\geq 10^3$ sec in which corrective action can be initiated. No damage was found in the fuel elements after the runs. (D.L.C.)

10212 FLUX TRAP RESEARCH NUCLEAR REACTOR. Pearce, William R.; Elgert, Oscar J.; Leonard, Byron H. Jr. (to Internuclear Co.). U. S. Patent 3,276,963. Oct. 4, 1966. Filed May 16, 1962.

A flux-trap research reactor includes a vessel pressurized to approximately 3.5 atm above the hydrostatic pressure of the light water pool in which it is submerged. Within the pressurized vessel, the annular core surrounds a light water island having a test wall or test hole. The light water island and core are cooled by pressurized light water flowing in a closed loop while the rod grasps of the controls, the reflector, and the central test well or test hole are cooled by pool water recirculated through a separate external cooling loop before being returned to the pool. (B.L.M.)

Reactor Components, Fuels and Accessories

Refer also to abstracts 8653, 9173, 9219, 9221, 9236, 9248, and 9251.

10213 (CONF-661001–36) SOME INPUT PROPERTIES FOR COMPUTER DESCRIPTION OF FUEL PROPERTIES. PART I. THERMAL PROPERTIES. Anderson, W. Kermit; Lechliter, Gerald L. (Knolls Atomic Power Lab., Schenectady, N. Y.). [1965]. Contract W-31-109-eng-52. 23p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

From 14th Conference on Remote Systems and Technology, Pittsburgh, Pa.

Use of analytic functions to input various physical properties of materials in a computer routine is discussed. Equations for gap or contact conductance, thermal conductivity of fuel, and thermal conductivity of Zircaloy-2 cladding material is presented. Comparisons with data are shown. (auth)

10214 (EURAEC–1754) BURNABLE POISON ADDITIONS TO UO_2. Progress Report, April 1–September 30, 1966. Koziol, J. J.; Christopher, S. S. (Combustion Engineering, Inc., Windsor, Conn. Nuclear Div.). Oct. 1966. Contract AT(30-1)-3107. 42p. (CEND–3107-277). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Work Performed under United States–Euratom Joint Research and Development Program.

Two 6%-enriched UO_2 fuel elements, containing 500 ppM B_4C were irradiated to burnups of approximately 1070 MWd/MtU and 5000 MWd/MtU at a peak specific power of 17.2 KW/ft. One element was destructively evaluated for both axial and radial B distribution. The other element is currently undergoing nondestructive evaluation. Evaluation of the first element revealed that gross axial movement of the B had not occurred. However, radial B movement was observed. The effect of this radial B movement on η_f (ratio of neutrons produced to thermal neutrons absorbed) and $\Delta\rho$ (difference in reactivity of the core) was investigated using the THERMOS program and found to be insignificant in both cases. (J.R.D.)

10215 (GEMP–61, pp 79-92) FISSION PRODUCT TRANSPORT PROCESSES IN REFRACTORY-METAL FUEL SYSTEMS. Conn, P. K. (General Electric Co., Cincinnati, Ohio. Nuclear Materials and Propulsion Operation).

Experiments on diffusion of krypton-85 in refractory metals are described. Diffusion coefficients increase with decreasing concentration, concentration gradient, and increasing distance of penetration. It is indicated that permeation of ^{85}Kr through Re, Ta, and W either does not occur or occurs at undetectably slow rates at 2300 to 2400°C. A computer program was devised to permit quantitative determination of individual isotopic components of composite gamma ray spectra and the study of fission product migration in refractory metals. (P.G.C.)

10216 (GEMP–61, pp 143-56) PHYSICO-CHEMICAL STUDIES OF CLAD UO_2 IN POTENTIAL MELTDOWN ENVIRONMENTS. White, J. F. (General Electric Co., Cincinnati, Ohio. Nuclear Materials and Propulsion Operation).

Results of dynamic steam corrosion tests on Zircaloy-4-clad UO_2 to determine amount of oxide, O_2-saturated metal, and unaltered metal existing at various temperatures, are reported. Isothermal steam corrosion tests on Zircaloy, Valoy, and on mild steel indicate that reactions are similar to those of 304 stainless steel. Thermal conductivity of Zircaloy-4 was measured at 1500°C and electric resistivity to 1400°C. (P.G.C.)

10217 (ORNL-TM–1675) PRESTRESSED CONCRETE IN NUCLEAR PRESSURE VESSELS: A BIBLIOGRAPHY OF CURRENT LITERATURE. (Franklin Inst., Philadelphia, Pa. Labs.

for Research and Development). Dec. 1966. Contract W-7405-eng-26; Subcontract No. 2721. 432p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

For Oak Ridge National Lab., Tenn.

Abstracts of papers, books, and reports on nuclear pressure vessels of prestressed concrete are presented. The references are grouped under the following headings: prestressed concrete reactor vessels, prestressing, concrete properties, vessel design and analysis, construction methods, and engineering design and performance controls. (M.C.G.)

10218 (RFP-658, pp 43-9) THE METALLOGRAPHIC PREPARATION OF IRRADIATED ZIRCONIUM-10 W/O URANIUM HYDRIDE. Krupp, W. E.; McAfee, D. D. (Atomics International, Canoga Park, Calif.).

A method for remote preparation of metallographic specimens of irradiated zirconium-uranium-hydride fuels are described. Subjects covered are mounting, polishing, and etching. (P.G.C.)

10219 (RFP-658, pp 124-36) FAILURE ANALYSIS OF THERMIONIC EMITTERS. Taketani, H.; Arnold, J. L. (Atomics International, Canoga Park, Calif.).

Failure analysis was performed on three thermionic emitters. An emitter consisted of a hollow cylinder with an outer cladding of Re, which served as an electron emitting surface, and an inner cladding of W. A cermet fuel was contained within the cladding and consisted of a mixed UC fuel within a W matrix. Failure was caused by the interaction of U with the emitter components. The mechanism for the formation of U from UC could not be determined. However, reaction of UC with O_2 impurities in the W matrix is offered as a possibility. (auth)

10220 ON THE BEHAVIOR OF THE FISSION GAS IN THE PARTICLE STRUCTURE OF A NUCLEAR FUEL PASTE. PART II. BUBBLE NUCLEATION AND GROWTH. Ziegenbein, D. (Zentralinstitut fuer Kernforschung, Rossendorf, Ger.). Kernenergie, 9: 306-10(Oct. 1966). (In German).

It is shown that the nuclei of the bubbles are created on fixed surfaces the creation being induced by the flying fission products for $\Theta < 90°$. For $\Theta > 90°$ steam bubbles form the nuclei. Taking into account diffusion processes does not seem to be necessary for the gas amounts produced in a fuel paste. The size of the bubbles is determined with a small error by the amount of the gas present. (auth)

10221 BURNUP ANALYSIS OF URANIUM DIOXIDE NONDESTRUCTIVE ANALYSIS BY EXTERNAL CONVERSION METHOD. Mitsui, Hidehiko (Hitachi Ltd., Ozenji, Japan). J. Nucl. Sci. Technol. (Tokyo), 3: 491-5(Nov. 1966).

Experiments on the nondestructive burnup analysis of UO_2 were made by external conversion method using a sector type double-focusing β-ray spectrometer. Details of the procedure are described. About 100 mg of UO_2 enclosed in an Al tube was irradiated and analyzed. The fission products used as burnup indicators were ^{95}Zr, ^{95}Nb, ^{140}La and ^{103}Ru. A code for fission product calculation developed in our laboratory was used in burnup determination. The burnup thus determined was 53.07 MWd/t. (auth)

10222 TRANSIENT TEMPERATURE DISTRIBUTIONS IN END CLOSURES OF ANNULAR FUEL ELEMENTS. Ma, Benjamin M. (Iowa State Univ., Ames). Nucl. Eng. Design, 4: 129-37(Aug. 1966).

The transient temperature distribution in bonded end closures of annular fuel elements of nuclear reactors is presented analytically. The solution for the temperature distribution is expressed by products of the Bessel functions, hyperbolic function, exponential time function, and coupling relations between the end closures and the fuel material of the fuel elements. From a numerical example for the Zr-alloy end closures and ceramic fuel material in a central nuclear superheating fuel element, the calculated results indicate that the temperature variation in the end closures decreases gradually with increasing time, Fourier number and, to a certain extent, enclosure length. (auth)

10223 CLOSURE OF FUEL ELEMENTS. Brutto, E.; Perona, G.; Sesini, R. (CISE, Milan). Nucl. Eng. Design, 4: 209-13(Aug. 1966).

A method is described for the end closure of claddings of fuel elements obtained by hot swaging. Cladding materials are dispersion hardened metals, and particularly SAP (sintered Al with Al_2O_3 dispersion) and NiTD (Ni sintered with ThO_2 dispersion). Results obtained are reported. (auth)

10224 FABRICATION OF STAINLESS STEEL CLAD FUEL RODS USING A Ni-P LAYER. Katsuta, Makoto; Fukushima, Eiji (Tokyo Shibaura Electric Co., Ltd.). Nucl. Eng. Design, 4: 202-8(Aug. 1966).

A Ni-P alloy is plated on the surfaces of cylindrical spacers for use in construction of fuel elements. Stainless steel cladding and spacer are joined mainly with primary crystals of Ni. The tensile strength of a joint is as high as that of a stainless steel substrate. Moreover, there is no detectable decrease in strength even after a high temperature and high pressure corrosion test. (auth)

10225 METHOD FOR PREPARING ACTINIDE OXIDE FUEL PARTICLES AND ARTICLE THEREOF. Beutler, H.; Beatty, R. L. (to U. S. Atomic Energy Commission). U. S. Patent 3,301,763. Jan. 31, 1967.

A method for preparing actinide oxide fuel particles having multiple C coatings is described. A low density, highly porous C coating is deposited on the fuel particles and then a thin, high density, impermeable layer of material is deposited onto this first layer. A second low density, highly porous C coating is deposited followed by a high density outer coating of pyrolytic C. (AEC)

10226 PRESTRESSED CONCRETE CONTAINMENT VESSEL. Mueller, Donald W. (to U. S. Atomic Energy Commission). U. S. Patent 3,301,041. Jan. 31, 1967.

A test explosion containment vessel is described having concentric steel spherical shells, a cushioning layer on the outside of the inner shell, and a solid core of concrete filling the remaining space between the shells. Tensioning bolts are associated with the outer skin to compress the concrete core so that during a confined explosion the concrete does not go into tension. (AEC)

10227 REACTOR FUEL-ELEMENT. Matsumoto, Masakichi (to Hitachi, Ltd.). Japanese Patent 1965-36080. Dec. 21, 1965. Filed Dec. 20, 1962.

In the proposed fuel-element, the fuel rods in the element frame are so arranged that coolant flows perpendicular to the fuel rods to increase the heat transfer and reduce the length of the rods. Each fuel rod is supported within the element frame by means of the supporting brims (of larger dia than that of the fuel rod proper) on each end of the rod; this brim rests on the upper side of the protrusion of the element frame. (J.R.D.)

10228 IMPROVEMENTS IN NOZZLE CONNECTIONS FOR PRESSURE VESSELS. Hiltscher, Rudolf. British Patent 1,042,537. Sept. 14, 1966. Priority date Aug. 21, 1963, Sweden.

A method is described for fabrication of unsymmetrical connections between pipes and curved areas on nonspherical pressure vessel walls. The construction is such that on the inner side of the vessel wall where the reinforcing effect of the external nozzle is low or nonexistent, the orifice is elongated so that very little stress concentration occurs. Outside of the vessel the nozzle reinforces the area and reduces stress concentrations. (J.R.D.)

10229 FUEL ELEMENT ASSEMBLY FOR A NUCLEAR REACTOR. Maillet, Ennemond (to Commissariat a l'Energie Atomique). British Patent 1,050,698. Dec. 7, 1966. Priority Date Oct. 26, 1962, France.

Design of a fuel element is described comprising a sleeve having a cross-sectional shape complementary to the cross-sectional shape of a space for receiving the assembly in a reactor core that is formed by removal of a moderator block. The sleeve defines a coolant channel. The fuel elements can be assembled in multi-unit groups according to the requirements of the coolant channel. (J.R.D.)

10230 PYROLYTIC CARBON COATED PARTICLES FOR NUCLEAR APPLICATIONS. Bokros, Jack C.; Goeddel, Walter V.; Chin, Jack; Price, Robert J. (to U. S. Atomic Energy Commission). U. S. Patent 3,298,921. Jan. 17, 1967.

Preparation of nuclear fuel particles coated with dense continuous jacket of isotropic C to increase stability under prolonged exposure to high temperature and neutron irradiation is described. (AEC)

GENERAL

10231 (ANL-7231) FORTRAN SUBROUTINES FOR HOUSEHOLDER'S METHOD IN THE COMPLEX CASE AND EIGENSYSTEMS OF HERMITIAN MATRICES. Mueller, Dennis J. (Argonne National Lab., Ill.). July 1966. Contract W-31-109-eng-38. 31p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

FORTRAN subroutines that use Householder's method to reduce a complex matrix to upper Hessenberg form in which the lower subdiagonal is real are presented. A separate subroutine is given for hermitian matrices. Here the reduced matrix is real, symmetric, and tridiagonal. Its eigensystem can be calculated by a standard routine given in the appendix. A subroutine is included, which transforms eigenvectors of the reduced matrix to those of the original matrix. (auth)

10232 (BNL-990) DATA EDITING AND PROCESSING COMPUTER PROGRAM FOR ULTRACENTRIFUGE MOVING BOUNDARY SCHLIEREN PATTERN CALCULATIONS. Trautman, Rodes (Brookhaven National Lab., Upton, N. Y.). June 1966. Contract AT(30-2)-Gen-16. 133p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Data editing and processing for Schlieren optical moving boundary ultracentrifugation using a FORTRAN IV computer program are described. The program requires a 32K memory, all-purpose digital computer and can presently process two-dimensional comparator data for sedimentation rate and concentration determination as well as perform least squares polynomial curve fitting of any data. Instructions for input, generalized formulas, main program, and subroutines are discussed. (H.G.D.)

10233 (IS-T-104) A MOESSBAUER EFFECT STUDY OF THE CRYSTAL FIELD POTENTIAL IN INTERMETALLIC COMPOUNDS OF THULIUM. Genin, Dennis Joseph (Ames Lab., Iowa). Nov. 1966. Contract W-7405-eng-82. 114p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Thesis.

Crystal field potentials in Tm-intermetallic compounds were investigated by measuring the temperature dependence of the nuclear quadrupole splitting of the 8.42 keV gamma transition in ^{169}Tm. Mössbauer effect investigations were carried out in the temperature range between 4.2 and 300°K. The quadrupole splittings were accurately determined by computer-fitting theoretical lineshapes to the data. Crystal field parameters for the C_{3v} symmetry in $TmRu_2$ and $TmMn_2$ were determined by a best fit to the temperature dependence of the quadrupole interaction. Over-all crystal field splittings were found to be 92 and 69 cm^{-1} in $TmRu_2$ and $TmMn_2$, respectively. In both compounds the conduction electron contribution to the electric field gradient was found to be opposite in sign to the temperature-independent lattice contribution. Large shielding of the 4f-electrons from the crystal field, expressed by the shielding factor σ_2, was noted. Anomalous line broadening at low temperatures was explained on the basis of a range of crystal field potentials at the Tm^{3+} ion sites due to lattice imperfections. (auth)

10234 (KAPL-A-EOS-1) THE ELEMENTS OF SPECIFICATIONS (REVISED). Fleischmann, W. L. (Knolls Atomic Power Lab., Schenectady, N. Y.). Nov. 15, 1965. Contract W-31-109-eng-52. 95p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The structure of a specification is a reflection of the nature of the specified item, whether novel or a modification of a common product, and of the purchaser-vendor relationship, depending on the policies employed in vendor selection. Together with format and phraseology, "The Elements of Specifications" considers those aspects of specifications in which management decisions play a major role. It discusses at length the engineering input required for the development of specifications of the performance and design type. Because of their general importance, some phases of material specifications are discussed separately. Though "specification engineering" is substituted for the commonly used term "specification writing," format and phraseology are covered as an important and necessary tool. The text is intended as a guide for engineers. (auth)

10235 (ORNL-3999) BIOLOGY DIVISION SEMIANNUAL PROGRESS REPORT FOR PERIOD ENDING JULY 31, 1966. (Oak Ridge National Lab., Tenn.). Nov. 1966. Contract W-7405-eng-26. 217p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Separate abstracts were prepared for 22 sections of this report. (H.L.W.)

For abstracts of individual sections see: 8674–8679, 8754–8760, 8847, 8913–8915, 9007, 9023, and 10236–10238.

10236 (ORNL-3999, pp 65-78) CELL GROWTH AND DIFFERENTIATION. (Oak Ridge National Lab., Tenn.).

Progress is reported on the following studies: elimination of mitochondria during Wolffian regeneration in newts; differential effects of actinomycin on ribosomal clusters in different phases of cellular differentiation of lens regeneration; effect of regenerating humor on lens regeneration; experiments on lens induction in the extraembryonic ectoblast of chick embryos cultured in vitro; purified phosvitin from vertebrate eggs; differentiation of lens cells in tissue culture-fibrogenesis; an immunofluorescent analysis of lens cell differentiation in vitro; formation of stable RNA templates in lens cell differentiation; analysis of RNA in embryonic and adult chick lens; relation between carbohydrate metabolism and protein synthesis in calf lens cells; physical and chemical properties of α-crystallines. (H.L.W.)

10237 (ORNL-3999, pp 125-6) GENERAL PHYSIOLOGY. (Oak Ridge National Lab., Tenn.).

Progress is reported on the following studies: attempts to isolate from cell extracts substances that control cell division in Escherichia coli; and isolation and characterization of ribosomes from Tetrahymena pyriformis. (H.L.W.)

10238 (ORNL-3999, pp 132-3) NUCLEIC ACID CHEMISTRY. (Oak Ridge National Lab., Tenn.).

Progress is reported on studies on nucleotide sequences in transfer RNA. Analysis of the oligonucleotides produced at 23° shows at least 11 minor nucleotides to be present in transfer RNA. The composition of transfer RNA reported earlier is now modified to include these data. Phosphate analysis of the oligonucleotides confirms earlier measurement on total transfer RNA. (H.L.W.)

10239 (USNRDL-TR-1084) DNA SYNTHESIS IN RELATION TO CELL DIVISION IN TETRAHYMENA PYRIFORMIS. Cameron, I. L.; Nachtwey, D. S. (Naval Radiological Defense Lab., San Francisco, Calif.). Oct. 12, 1966. 33p.

The effects of different nutritional conditions on the durations of the G_1, S, G_2, and D periods of exponentially replicating Tetrahymena pyriformis strain HSM were determined by autoradiographic techniques and observation of individual cells. The data indicate that, with decreased availability of nutrients, DNA synthesis is initiated proportionately later in the cell division cycle and that the proportion of the cell cycle spent in DNA synthesis increases. The effects of temperature on the relationship of the phases of the cell cycle were examined. Between 29° and 20° C, the generation time and the time spent in the G_2 period approximately doubled, while the time spent in the S phase remained about the same. This phenomenon results in a reduction in the proportion of the generation time spent in the S phase and a compensatory increase in the G_1 phase proportion. The results are related to nutritional factors involved in initiation and maintenance of DNA synthesis. (auth)

10240 (AEC-tr-6770) RADIOBIOLOGY. Translation of Radiobiologiya, 6: 3-160(1966). 254p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Abstracts were prepared previously from the original Russian language publication of Radiobiologiya, Vol. 6, No. 1. (H.L.W.)

10241 (TT-65-50023/5) HYGIENE AND SANITATION. Translation of Gig. Sanit., 29: No. 5, 1-128(1964). 181p. (IPST-Cat.-1390). CFSTI $5.00 cy, $1.00 mn.

A separate abstract was prepared on one paper included in this translation of the Russian-language journal Gigiena i Sanitariya. Other papers discuss various aspects of industrial hygiene and safety. (C.H.)

For an abstract of the individual paper see: 10242.

10242 (TT-65-50023/5, pp 126-32) DATA ON THE EFFECT OF OXIDES OF THE RARE-EARTH METALS ON THE ORGANISM. Mezentseva, N. V.; Mogilevskaya, O. Ya.; Roshchina, T. A. Translated from Gig. Sanit., 29: No. 5, (1964).

The toxic effects of 7 rare earth metals were studied after intraperitoneal or gastric administration to mice. The metals studied included Ce, Dy, Eu, Gd, La, Nd, and Sm. Oxides of the metals were far less toxic than chlorides or citrates. The toxic effects of oxides of Dy, Eu, Gd, and Sm were studied after gastric administration to guinea pigs. Results indicated that oxides of these rare-earth metals had no pronounced toxic effects. Inhalation studies in rats killed 5 or 9 mo after introduction of 50 mgm of oxides of Dy, Eu, Gd, Sm, or Y in the form of dusts. Nodules consisting of accumulations of dust and cellular elements were found after 5 mo and regional lymph nodes were enlarged. Animals examined after 9 mo had larger modules,

more extensive lymph node involvement, moderate fibrogenesis, and slight sclerosis in pulmonary tissues. It was concluded that oxides of rare-earth metals are only slightly toxic but induce pronounced pathological changes in the lungs with the degree and character depending on the action of dust of the different oxides. It is pointed out that rare earth metals are oxidized in air at normal temperatures and during heating there is a possibility of the air of workrooms being contaminated with aerosols. (C.H.)